MACHINERY.

August, 1908.

LAUNCHING A GREAT LAKES FREIGHTER.

RALPH E. FLANDERS.*

THE work of the engineer, for the most part, has a dull and uninspiring aspect. Years of experience may have been brought to bear on the design and manufacture of a 90-pound rail, but the traveler who is whirled madly over it in the eighteen-hour train, knows little of the care and skill expended in perfecting this one of the many details which have to be perfected, if his journey is to be reasonably safe and comfortable. The planning and construction of the water system of a great city requires engineering ability of the highest kind, and on the successful solution of the problems involved, depend the health and happiness of thousands of human beings; but, aside from an incidental spectacular undertaking, like the Croton Dam, or the long intake tunnels of the cities bordering on the Great Lakes, there is nothing beyond the occasional frozen pipe or too industrious meter, to draw the attention of the householder to any point more distant than the faucet from which he obtains his supply.

When it comes to the building of a vessel, however, the engineer has his turn, particularly in the act by which the completed hull is transferred from the solid ground on which it was built, to the water which is thenceforth to bear it throughout its useful life. The launching of a vessel is spectacular in the extreme, and has excited the imagination of poets and moralists for generations; and there is no purely engineering event which has such a fascination for the common, everyday, unimaginative citizen who is fortunate enough to witness it.

From what has just been said, the reader may perceive (even if the thought would not occur to him naturally) that Mr. Pessano, president of the Great Lakes Engineering Works, provided a most satisfactory spectacle when he arranged for the launching of a large freighter during the time of the convention of the American Society of Mechanical Engineers, at Detroit, last June. Not only was the event spectacular, as intimated, but the means provided for supporting the hull on land and launching it to the water, are of such an interesting nature, mechanically, that quite possibly a brief description of them will be appreciated by the reader.

In the first place, we will have to understand a little something of the way in which the hull of a vessel is erected. In the shipyard in question, the work is carried on in a very systematic fashion. The various plates and beams which go to make up the keelson, frames, sides, etc., are all cut, drilled, and formed in the shops, to patterns carefully prepared in the mold loft, from drawings furnished by the designers. As these parts are completed, they are taken to the berth in which the vessel is to be constructed, where they are assembled into place in their proper order, it being taken for granted that no further drilling or fitting will be required. The keel plates and keelson are laid, the frames erected, and the side and bottom plates temporarily bolted in place, all with astonishing rapidity.

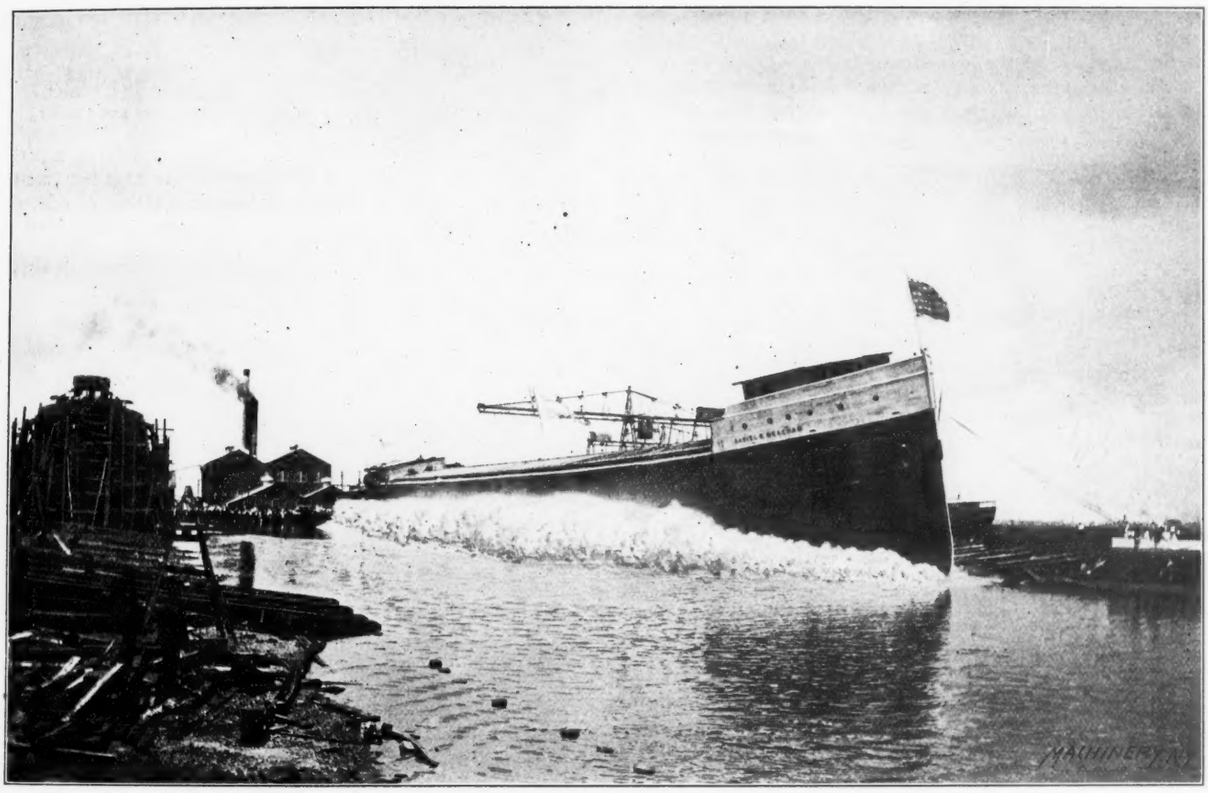


Fig. 1. The Launching of the 10,500-ton Lake Steamer, the Daniel B. Meacham; an Event of the Detroit Meeting of the A. S. M. E.

The whole structure is supported, with the flat bottom five or six feet from the ground, on piles of heavy blocking, placed under the various frames, where the great weight of the hull can be borne without damage to it. These piles of blocking will be seen in Figs. 2, 3 and 4, where they are shown resting on the ground, being thus distinguished from those to be described later, resting on the sloping beams or "ways."

It will be seen that each of these piles is capped by a block set on wedges, by means of which the support given the hull may be increased or relieved. The necessity for this will be understood when it is remembered that each of these many supports has to be removed during the progress of the work,

* Associate Editor of MACHINERY.

to permit rivetting the holes in that portion of the hull which it conceals. As the rivetting proceeds, and these piles of blocking are from time to time removed, the weight reposing on each is transferred (by means of the wedges) to new piles, placed in adjacent positions under completed areas of the hull. It will thus be seen that when the dry land work is finished, every one of the original supports has been removed, and the whole weight transferred to a new foundation.

As the hull approaches completion, preparations are made for the launching. It should be understood that these flat-bottomed, cargo-carrying vessels are, in the Great Lakes district, launched sideways into the water. This can be done into a narrow slip, without obstructing navigation in the channel. No cradle is required for supporting the sliding hull, as is necessary with sharper built, high-speed vessels.

Before the time set for launching, the sloping beams known as the "ways," and shown in all the illustrations, are solidly laid beneath the vessel, with their smooth upper surfaces lined up in the same plane with each other. New piles of blocking (shown in Figs. 2, 3 and 4) are then erected on the ways, with top blocks supported by wooden wedges whose ends are barely entered, as shown best at *A* in Fig. 3. Before laying this blocking, the surface of the way beneath the pile is greased, and a dog is driven in to prevent the blocking from slipping, until the hour arrives for the launching.

When everything is ready, all the wedges *A* in all the piles are driven in, and the whole ship is thus lifted onto the ways. The stationary piles, such as *B* in Fig. 3, are then loosened and

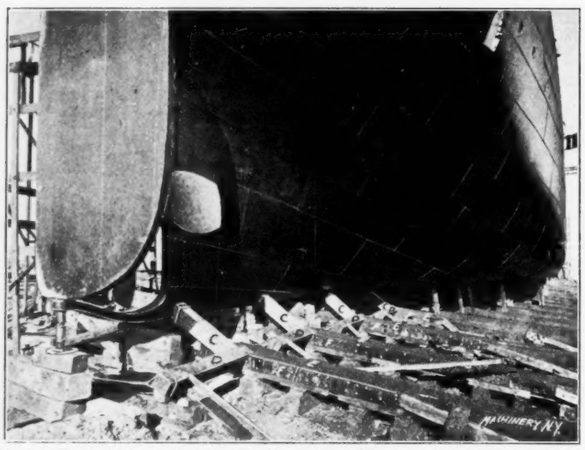


Fig. 2. View of Stern showing the Launching Ways, and the Three Triggers which retain the Vessel at this End.

knocked out of the way. To facilitate this, it will be noticed that in pile *B* is a double wedge block, held together by a steel plate with cross pins at each end. If the hull is not entirely lifted from the blocking, the removal of the pin in the plate permits the upper wedge block to slide off the lower one as soon as the vessel begins to move.

Provision has to be made to keep the vessel from sliding off into the water after it has been raised onto the ways by the driving of the wedges, and before the moment for launching arrives.

To effect this, struts or "dog shores" *C* (as shown in Figs. 2, 3 and 4) are set against the seam of the keel-plate of the vessel, with their lower ends bearing on triggers *D*, which, in turn, are supported at the inner ends against abutments *F* on the sides of the ways *E*. The dog shore and the abutment are so located as to make each trigger a lever of high ratio, and the force with which the vessel tends to slide down the ways is transferred (in diminished degree) to the wire ropes looped around the outer end of each. As may be seen in Fig. 4, these wire ropes are carried to the upper side of the berth, where they are attached to posts in the ground by ropes and tackle blocks, by which the triggers and dog shores are strained up against the keel-plate. It is the chopping of these ropes, where they are looped around the posts, that finally releases the vessel.

In this case there were eight triggers—three each at the bow and stern, and two amidships. In Fig. 4 a workman is shown in pantomime in the act of cutting one of the trigger ropes. If he had done it in reality at the time the picture was taken, it is well within the bounds of possibility that he might have been "fired."

The order of procedure in launching is something like this: First, the exposed portion of the upper side of the ways is greased, the area under the blocking having been already treated, as explained. Then a small army of men is set at work driving the wedges (see *A* in Fig. 3), which raise the

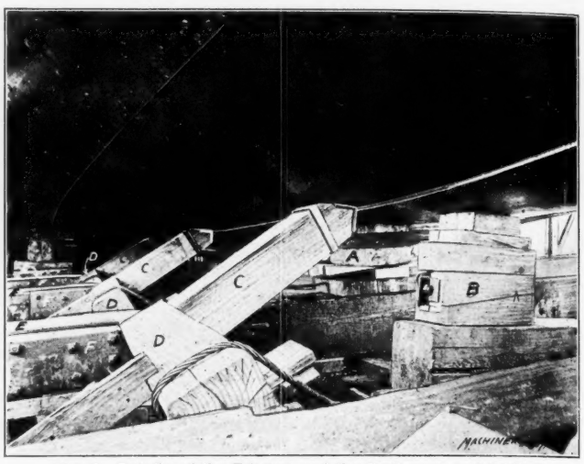


Fig. 3. Details of the Trigger, and the Stationary and Sliding Blocking under the Bow.

vessel onto the ways. After a few minutes of driving, a period of rest follows, to allow the blocking to settle as it receives the weight. Then a second period of driving, another of rest, and the final drive, which leaves most or all of the ground blocking free, the vessel being now held from sliding only by the triggers and the dogs driven into the ways.

As the blocking and the dogs are removed from each section, the foreman of that section, assured by careful inspection that everything is free, removes from the ground a white stake, previously set outside of his section. In addition, there are three stakes at each end of the line, representing the three piles of keel blocking at the stem and the stern. As the clearing away of each section proceeds, the superintendent is informed of the progress of the work by the successive removal of the stakes, and the final removal of the keel block stakes at the ends. When all is thus known to be ready, the time for launching has arrived, and the workmen come out from under.

Now the speeches are made, and the girl with the champagne bottle takes her place on the stand at the prow. Then

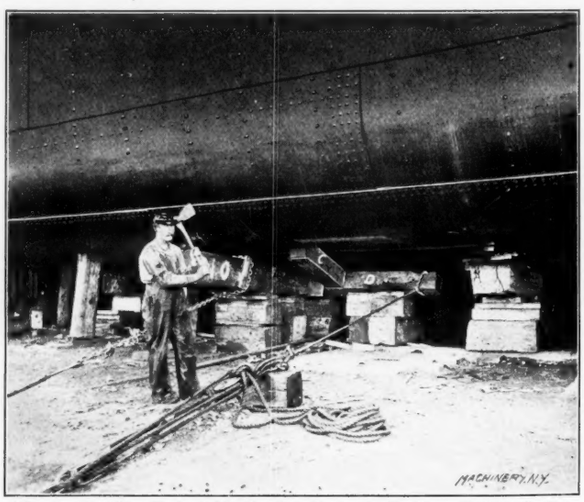


Fig. 4. The Man that wields the Axe that cuts the Rope that binds the Trigger that holds the Ship.

the superintendent gives the order, and the two amidship trigger ropes are cut. The ship is flexible enough to spring down the ways several inches when this is done, being still held at the stem and stern. A fixed gage is generally set in the ground amidships, just touching the side of the vessel before the triggers are released. The deflection is measured by the resulting gap, to get some idea of the ridigity of the

structure. Finally the order is given to cut the stem and stern trigger ropes, and the vessel is thereby released.

This whole mechanism, it will be seen, is of the simplest. In its essentials, it has been changed little in generations, though it has been modified somewhat for the sidewise launching. The carefulness of the axmen in cutting the trigger ropes at the moment of the signal, is relied on to release both ends simultaneously.

The launching at Detroit was witnessed by the members and guests from the decks of the steamer *Brittania*, which lay out in the stream two hundred feet or so from the entrance to the slip. It was a gala day for the assembled employes and their families, as well as for the engineers. The army of workmen beneath the vessel had made their first and second drives before we arrived, and were engaged in their third as our boat took its position. The innumerable hammer blows, whose aggregate force bodily raised the great mass, sounded like the rattle of a battery of rapid-fire guns. We were too far away to hear the orders, or the speech-making, but we could see the white stakes disappearing, one after the other, and knew that the sharp eyes of the superintendent were watching them also. Finally, after what seemed an interminable wait, the stern started slowly down the ways, with the bow following a fraction of a second later. It slid thus, slightly canted, gathering

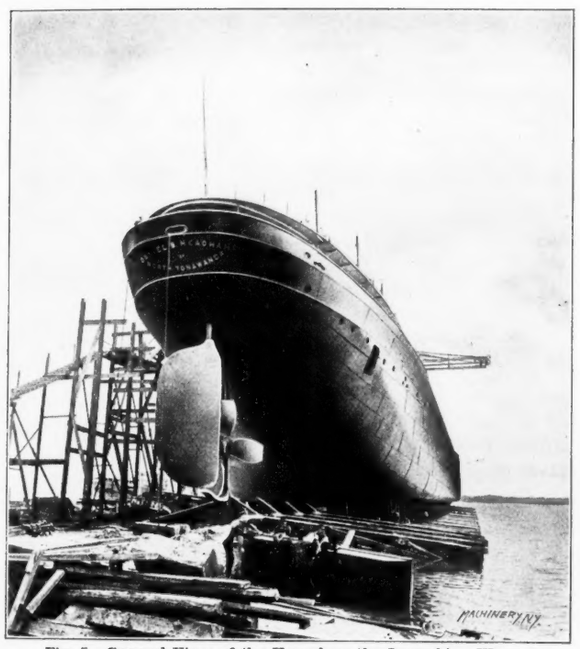


Fig. 5. General View of the Vessel on the Launching Ways.

speed as it went, and finally shot off the ways into the water, gracefully clearing their dangerous-looking lower ends.

There may have been some in the party who saw the girl in white, smash the beribboned bottle on the prow as the vessel slipped away. It is impossible to see everything at once. The writer's clearest recollection is that of watching the great broadside wave kicked up by the hull, pour over the further edge of the slip, and up onto the land, mixing lumber piles, spectators, and relics of the blocking in one long, confused windrow. None of the unfortunates were drowned, but they were all badly "mussed."

The movement of the vessel was arrested before it struck the other bank, partly by the tremendous resistance offered by the hull against the confined water of the slip, and partly by the numerous cables by which it was connected with the shore. The launching was said to have been one of the most successful on record.

The *Daniel B. Meacham*, for thus the vessel was christened, is to add one more to the wonderful navy of freighters which ply the waters of the Great Lakes. It is one of the sights of the world to watch, from the meadows about this shipyard, the vessels of this great navy as they pass up and down between the grassy banks of the beautiful Detroit River. Long and low, with texas and pilot-house at the prow, and engines, boilers, and crews' quarters at the extreme stern, they are built for "strictly business"—but the builders are proud of them. It is difficult to believe it, but the total tonnage passing through the Detroit River in the eight or nine months the channel is open, exceeds the combined annual tonnage of the harbors of New York, London, Liverpool, and Hamburg. One of these stately freighters passes the city, on an average, every seven minutes, weighted with its cargo of ore, coal, or wheat. Perhaps some time we will build a canal which will release this fleet from its narrow bounds, and permit it to carry our produce and our flag to countries across the sea.

* * *

A certain wealthy man living in New Jersey, not many miles from New York City, maintains a large estate. It is stocked with fine horses and cattle, and has a modern dairy. The surplus milk from this dairy is sold to customers at a price slightly above that received by neighboring dairymen whose dairies are not kept in as scrupulously clean and hygienic condition. Certain captious critics found fault with their wealthy neighbor's enterprise and asked why this man who possesses so much of the material things of life should so demean himself as to "peddle milk." They and others suggested that the eminently proper thing to do with his surplus milk was to give it away to the deserving poor, to charitable institutions, hospitals, etc. It seemed to them to be the only course a wealthy man could follow without doing an injustice to his dairymen neighbors and lowering his position. This mistake, for mistake it certainly is, arises from two causes; the first is pure snobbery, and the second cause, with which this note is concerned, is a mistaken idea of the source of wealth. Wherein is this man wealthy? In his possession of ways and means that enable him to command the labor of others? He has title to land, houses, barns, stock in transportation lines, mines and other wealth-producing enterprises. He, in one way or another, directs the energies of many thousand persons, but he cannot waste their energies without causing economic loss. If he chose to give away the milk produced on his dairy farm it would simply mean in the last analysis that he orders certain laborers or servants to work for other individuals for no compensation. The fact that his personally employed servants receive payment from him does not matter. The persons benefiting by his charity would give no recompense, and such practices would be ruinous if followed on a large scale. Because a man is wealthy, it does not give him the right to waste the work of others. The law of supply and demand hinges on the principle of compensation, and is as immutable as the law of conservation of energy.

* * *

The daily press, and even some technical journals, have published a statement to the effect that a "wireless" truck has been in operation in the yards of the Union Pacific's Omaha shops, this being the latest development in wireless transmission of electrical power. It was stated that this truck was used to haul a string of smaller trucks, loaded with material, from one point in the shops to another, the source of power being a wireless station in the center of the shop plant. It has been stated that the inventors of this wireless power transmission scheme are Dr. Frederick H. Millener and W. R. McKeen, Jr., the latter superintendent of motive power of the Union Pacific Railroad Co. We have been informed by Mr. McKeen, however, that the newspaper articles printed in regard to the operation of the "wireless" truck at the Omaha shops have been considerably exaggerated. The facts in the case are that for experimental purposes a storage battery truck has been equipped with necessary receiving wires, and wireless waves have been used in connection with a wireless telegraph outfit for connecting and breaking the circuit between the batteries and the motor on the car, thereby starting and stopping the latter.

* * *

Engineers, at the outset of their professional careers, are taught to give honest work for their money, and being absorbed in the study of truths of nature, are forced to forego the cunning whereby to possess themselves of money and power which they have not earned.—*W. D. Marks, in Engineering News.*

THE DESIGNING OF MACHINE FRAMES.

E. A. FESSENDEN.*

For men of limited experience, a machine frame of the common C-type, such as is used in punching and shearing machines, in some kinds of riveters, and, in a modified form, in slotters, drill presses, steam hammers, and many other tools, is always more or less difficult to design. The stresses are rather complex, and the means for securing the best distribution of metal for bearing these stresses is not easy. Much has been written on the subject, and the author of this article does not claim any originality in the ideas involved in the discussion. It is believed, however, that the method of presenting the solution of the problem has some points that may merit consideration. A common punching and shearing machine frame will be used for illustration, because the form and proportions of these frames are so well known. The method employed, however, is perfectly general and may be used for many other machine frames.

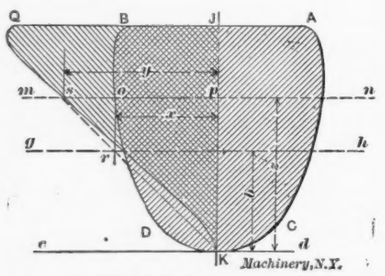


Fig. 1. Graphical Method for Finding the Center of Gravity.

In the discussion which will follow, it will be necessary to use the moment of inertia and center of gravity of an irregular section. The method of finding these quantities, which is outlined below, is not original with the author, but he has not seen it previously published, and it is presented here in the hope that its use may become more general.

The following graphical method for finding the center of gravity and moment of inertia of an irregular figure, will be found to offer an advantage over the ordinary method by calculation, in the matter of time saved.

Let *ABDC*, Fig. 1, represent any irregular section. In the figure, a section symmetrical about a vertical axis is shown, and the construction carried out for half of the figure. For an unsymmetrical section, both sides would have to be considered, as well as a construction for the gravity axis parallel to two base lines. A case of this sort will rarely arise in practice.

Lay off the line *gh* at any distance *b* from the edge of the section. The line *gh* is perpendicular to the center line *JK*. Then lay off another line *mn*, parallel to *gh*, at any distance *z* from *cd*. Let the distance *op* be called *x*. From *o* drop a perpendicular on *gh* cutting at *r*. Join *K* and *r* and extend the line until it cuts *mn* at *s*, and let *sp* = *y*. After determining several points *s* in the same way, connect them by a smooth curve, giving the figure *KQJ*.

Then by our construction, we have,

$$\frac{y}{x}=\frac{z}{b}; \qquad y=\frac{xz}{b}$$

The area of *KQJ* is

$$G=\int ydz=\frac{1}{b}\int xzdz$$

But $\int xzdz$ is the "static moment" of the original figure *KDBJ*, and therefore *bG* is the static moment of *KDBJ* about *cd*. If *A* is the area of *KDBJ*

$$\frac{bG}{A}=\frac{\text{static moment of } KDBJ}{\text{area of } KDBJ}$$

$$=\text{distance from } cd \text{ to center of gravity} = e.$$

If the areas *A* and *G* and the distance *b* are measured, the distance to the center of gravity is readily found from this last equation. A planimeter offers the best means of measuring the areas, but if this is not possible, sufficient accuracy may be attained by dividing the areas to be measured into rectangles and triangles, computing their separate areas and taking the sum of the areas of all the subdivisions as the area of the original figure.

* Address: University of Missouri, Columbia, Mo.

There is a similar construction for finding the moment of inertia, that should be carried out on the same figure as was used for finding the center of gravity. The two constructions are separated here in order to avoid confusion in explaining them.

In Fig. 2 the lines *gh* and *mn* are laid off as before so that *pq* is *x*, and *pw* is *y*. Then *we* is drawn from *w* perpendicular to *gh*; join *K* and *e* and extend *Ke* to *f*, making *pf* = y_1. Several points *f* will give the figure *KSJ*, and we have, as before

$$\frac{y}{x}=\frac{z}{b}; \qquad y=\frac{xz}{b}$$

and also,

$$\frac{y_1}{y}=\frac{z}{b}; \qquad y_1=\frac{yz}{b}=\frac{xz^2}{b^2}$$

Then the area of *KSJ* is

$$J=\int y_1dz=\frac{1}{b^2}\int xz^2dz$$

but the moment of inertia

$$I=\int xz^2dz$$

from which

$$J=\frac{1}{b^2}I; \text{ and } I=b^2J.$$

In this equation we know *b*, and can measure *J* as before.

This construction gives the moment of inerita about the line *cd*, whereas it is generally required about the gravity axis. It might have been so found if the base line had been the gravity axis instead of the line *cd*. However, the mathematical computation for the transformation of axes is easily made. The following formula should be used:

$$I_o = I_{cd} - e^2A,$$

where I_o = moment of inertia about gravity axis,
I_{cd} = moment of inertia about *cd*,
e = distance from *cd* to center of gravity,
A = area of *KDBJ*.

It is to be clearly understood that the values of *e* and *I* found above refer only to the figure actually drawn on the drawing

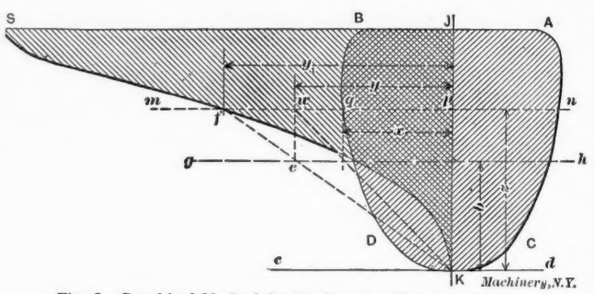


Fig. 2. Graphical Method for Finding the Moment of Inertia.

board and not to the full-sized section. For the actual values we have

$$I_{\text{actual}} = X^4 I_{\text{drawing}}$$
$$e_{\text{actual}} = Xe_{\text{drawing}}$$

where *X* is the scale of the drawing.

Fig. 8 shows the construction applied to a punch frame section.

The Stresses Involved in a Punch Frame.

Let Fig. 3 represent the side view of a punch frame. It will be sufficient to investigate the stresses at four different sections, testing at other points later if it appears necessary. The preliminary calculations will be made on sections indicated at *AB*, *CD*, *EF*, and *GH* or *JK*.

For determining the stresses on the section *AB*, consider the upper portion of the punch a "free body" as shown in Fig. 4. It is subjected to an external force *P*, acting upwards, arising from the resistance of the material being punched. In the actual punch this force tends to separate the jaws. To balance *P* there is an internal stress acting over the section *AB*. The following discussion will show that this internal stress is a compound stress.

Conditions of equilibrium require that the algebraic sum of all forces, external and internal, acting on a body, must be zero; and also that the sum of all couples, or forces tending

to produce rotation, must be zero. It is then evident that to balance P there must be downward forces equal to P. Such downward forces exist in what may be considered as a uniform tensile stress of t_1 pounds per square inch over the section AB. The resultant of all these small downward forces making up the uniform tensile stress, can be considered as a single force P_1, equal to P, acting at the center of gravity of the section AB. The algebraic sum of all the forces on the free body is now zero, but P and P_1 together form a couple of value $Pl_1 = P_1l_1$, tending to rotate the portion of the punch under consideration in a clockwise direction, so that an equal and opposite internal couple is necessary to balance it. This

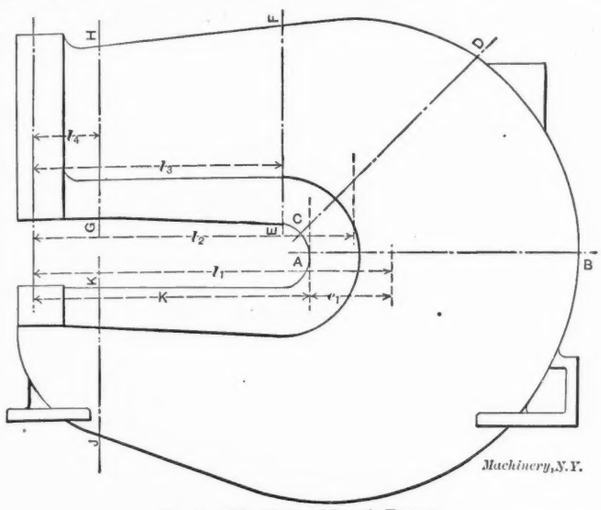


Fig. 3. Side View of Punch Frame.

internal couple acts over the entire surface of the section AB, and may be considered as being made up of an infinite number of small couples, each consisting of a tensile stress on the throat side of the frame section and an equal compressive stress on the outer part of the section. (See Fig. 4.) Then the total internal stress may be found by combining these elementary stresses as shown.

The following formulas are used to calculate the values of these internal stresses. Their derivation is comparatively simple, and may be found in any treatise on the mechanics of materials.

$$P = \pi dts, \qquad (1)$$

where d = greatest diameter of hole to be punched on the machine considered,
t = thickness of plate punched,
s = shearing strength of material punched.

$$t_1 = \frac{P_1}{A_1} = \frac{P}{A_1}, \qquad (2)$$

where t_1 = uniformly distributed tensile stress over section AB, in pounds per square inch,
A_1 = area of section AB, in square inches.

$$f_1 = \frac{P_1 l_1}{N_1} = \frac{M_1 e_1}{I_1} \qquad (3)$$

where f_1 = tensile stress at point A, due to couple P_1l_1, in pounds per square inch,
l_1 = arm of couple in inches $= K + e_1$ (Fig. 4),
e_1 = distance from center of gravity of section to edge next to punch throat, in inches,
N_1 = section modulus, for tension, of section $AB = \frac{I_1}{e_1}$,
M_1 = bending moment in inch pounds,
I_1 = moment of inertia of AB about gravity axis.

$$c_1 = \frac{P_1 l_1}{Z_1} = \frac{M_1 z_1}{I_1} \qquad (4)$$

where c_1 = compressive stress, in pounds per square inch, at point B, due to couple P_1l_1.
Z_1 = section modulus of section AB, for compression, $= \frac{I_1}{z_1}$
where z_1 is the distance from the center of gravity to the outer edge of the section.

The following equations may be written for the maximum stresses on the section AB.

Maximum unit tension

$$= T_1 = t_1 + f_1 = \frac{M_1 e_1}{I_1} + \frac{P_1}{A_1} = \frac{P_1 l_1 e_1}{I_1} + \frac{P_1}{A_1} \qquad (5)$$

Maximum unit compression

$$= C_1 = c_1 - t_1 = \frac{M_1 z_1}{I_1} - \frac{P_1}{A_1} = \frac{P_1 l_1 z_1}{I_1} - \frac{P_1}{A_1} \qquad (6)$$

In equations (5) and (6) everything is known from the conditions that would be given in the problem, as it is received by the designer, except the quantities $\frac{c_1}{I_1}$, $\frac{z_1}{I_1}$ and A_1. It will be seen that these are all factors depending on the size and shape of the section AB under consideration, and these are for the designer to determine.

Method of Designing Frame.

After clearly understanding the stresses involved in the design, the next step will be to proportion the frame to withstand these stresses. This may be accomplished in the following manner:

1. Assume the shape of the section at AB, Fig. 3. In making this assumption the designer will have to be guided by experience, either his own or that of others as shown in machines already built, catalogues, textbooks, drawings, photographs, or any other means of gaining information that is available. The section shown in Fig. 8 will give a fairly good idea of the commonest form used for punches. In making the first drawing it is not necessary to make any assumption as to the *size* of the finished section; the *shape* is all that is necessary.

2. Lay out this section on a drawing board. Use any scale, and make the drawing rather large, say eight inches as the longest dimension. The *size* is of no particular importance, only be careful to get the figure drawn of the same proportions as desired in the final section.

3. Find the gravity axis and the moment of inertia of the figure drawn, by the graphical method explained above.

4. It is evident that the figure drawn will not be the correct *full sized* section of the punch, but it will be a drawing of that section to some scale. Let that unknown scale be such

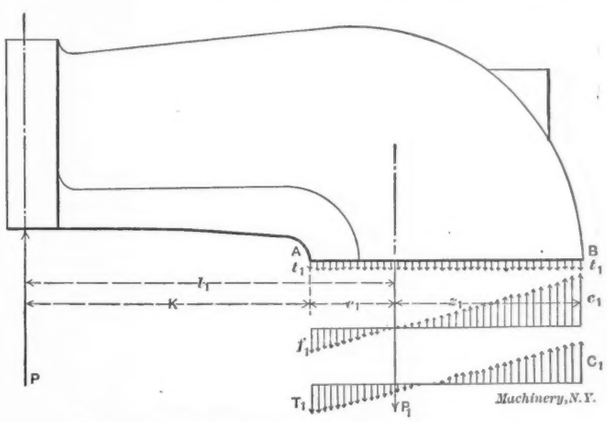


Fig. 4. Graphical Illustration of Stresses in Punch Frame.

that one inch on the drawing represents X inches on the actual section. If, then, quantities relating to the figure on the drawing board are represented by letters with the subscript d, and quantities relating to the actual section, by letters without additional subscripts, the following equations will hold true:

$$e_1 = X(e_1)_d \qquad (7)$$
$$z_1 = X(z_1)_d \qquad (8)$$
$$A_1 = X^2(A_1)_d \qquad (9)$$
$$I_1 = X^4(I_1)_d \qquad (10)$$

We can measure $(e_1)_d$, $(z_1)_d$, $(A_1)_d$, and $(I_1)_d$ directly from the drawing, and insert the values for e_1, z_1, A_1 and I_1 in equations (5) and (6). We then have

$$T_1 = \frac{P_1 l_1 X(e_1)_d}{X^4(I_1)_d} + \frac{P_1}{X^2(A_1)_d}$$

$$= \frac{P_1[K + X(e_1)_d]X(e_1)_d}{X^4(I_1)_d} + \frac{P_1}{X^2(A_1)_d} \qquad (11)$$

$$C_1 = \frac{P_1 l_1 X(z_1)_d}{X^4(I_1)_d} - \frac{P_1}{X^2(A_1)_d}$$

$$= \frac{P_1[K + X(e_1)_d]X(z_1)_d}{X^4(I_1)_d} - \frac{P_1}{X^2(A_1)_d} \qquad (12)$$

Equation (11) can now be used to solve for X, if the allowable value for T_1 is known. A machine of the punch or shear type is subject to severe shock at the moment the tool strikes the metal. For this reason a very low allowable safe stress should be taken. It is suggested that the maximum allowable tensile or shearing stress be not greater than 2,000 to 2,200 pounds per square inch for cast iron. Equation (11) is a

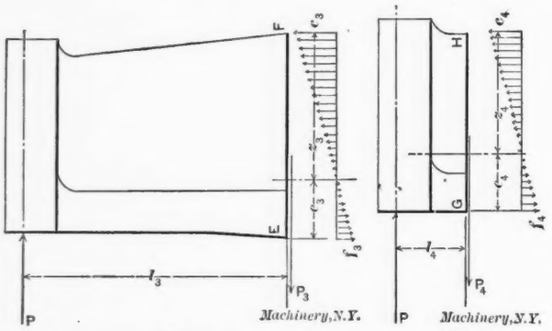


Fig. 5.

Fig. 6.

Graphical Illustration of Stresses in Punch Frame.

4th power equation, and the quickest and easiest way to solve it is by trial. After finding the value of X from equation (11), it can be substituted in equation (12) to find the value of C_1. This should not exceed 8,000 to 10,000 pounds per square inch. It will usually be found much less than this, because mechanical difficulties are encountered in the manufacture of the punch if the outer part of the section is made thin enough to raise the compressive stress to the highest allowable value. These difficulties are mainly in the shape of extremely high cooling strains in the casting, so that the risk is too great to compensate for the comparatively small saving in iron. Take the value of X found, and apply it to the original drawing to find the actual size of section. All linear dimensions of the drawing will be multiplied by X to get the actual size. This will fully determine section AB.

Having section AB, there are two methods of determining other sections. They may be found in a manner exactly similar to that used for section AB, by assuming a *shape* of section and solving for the *size*, or the size and shape may both be assumed and then tested for safety. The latter method will undoubtedly give the most satisfactory results, because it would probably require a great many trials by the first method for the reason that while each section would be strong enough to bear the stresses upon it, there would be considerable difficulty in combining these independently found sections into a pleasing and harmonious whole.

After finding section AB, use it as a basis, together with all the other known data about the punch, from which to assume an outline of the side view. In this part of the work, as in the first assumption of the shape of section AB, reference must be made to the results of past experience, and here again books, drawings, and illustrations will be found helpful. Fig. 3 is a side view of the frame of a punch made by one of the largest manufacturers of machine tools in the United States; if nothing better is at hand, it may be used as a guide. The thickness of the outer part of the frame is kept the same as was found for the section AB, and the frame is a trifle narrower from side to side at the tool end than at the back end.

Now, consider a section along some plane EF, parallel to the line of action of the tool. The "free body" is shown in Fig. 5. The forces acting on the free body are found in a manner very similar to that used in discussing the stresses in the section AB. Let all quantities relating to this section be denoted by the subscript 3, and have the same meaning as the same letters had when used with subscript 1 in the discussion of section AB. The following equations may then be used to determine the stresses on the section.

P = the punching pressure.

P_3 = a force equal and opposite to P, causing shearing stress along EF.

P and P_3 with arm l_3 form a couple. This tends to produce bending in the frame and must be resisted by an internal moment of equal magnitude, M_3.

$$M_3 = P_3 l_3 = P l_3. \qquad (13)$$

As before, we have the tensile stress in section EF at E due to the couple as

$$f_3 = \frac{M_3 c_3}{I_3} \qquad (14)$$

and the compressive stress in the section at F, due to the couple as

$$c_3 = \frac{M_3 z_3}{I_3}. \qquad (15)$$

The shearing stress is distributed uniformly over the entire section and its value is

$$s_3 = \frac{P_3}{A_3} = \frac{P}{A_3}. \qquad (16)$$

The maximum tension, compression, and shearing effects are found by combining f_3, c_3, and s_3, according to the rules found in various works on the mechanics of materials. "Kent's Mechanical Engineer's Pocketbook" (7th edition, p. 283) gives the following rules, taken from Prof. Merriman's "Strength of Materials."

$$T_3 = \tfrac{1}{2} f_3 + \sqrt{s_3^2 + \tfrac{1}{4} f_3^2} \qquad (17)$$

$$C_3 = \tfrac{1}{2} c_3 + \sqrt{s_3^2 + \tfrac{1}{4} c_3^2} \qquad (18)$$

$$S_3 = \pm \sqrt{s_3^2 + \tfrac{1}{4} f_3^2} \quad \text{or} \quad \pm \sqrt{s_3^2 + \tfrac{1}{4} c_3^2} \qquad (19)$$

Since the value of s_3 is uniform over the entire section, while the stresses due to the couple are variable, it is evident that the maximum shearing effect will occur at that part of the section where the stresses due to the couple are a maximum, *i. e.*, probably at F.

The section must be designed strong enough to resist both tension and shear. In general, it is not possible to make it equally strong to resist both, when such a material as cast iron is used. At a section near the end, the shearing stress may be the one to fix proportions, but when taken near the back of the throat, the tensile stresses are more liable to require consideration.

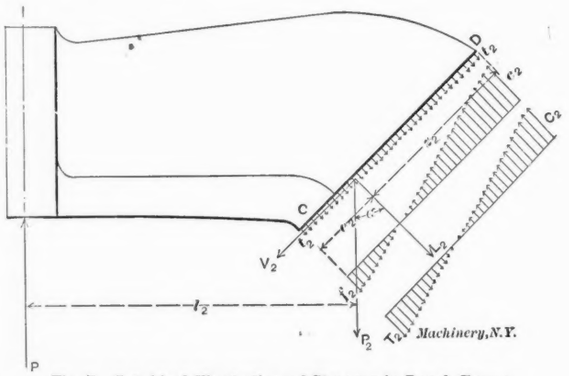


Fig. 7. Graphical Illustration of Stresses in Punch Frame.

Equations (17), (18), and (19) should be solved for T_3, C_3, and S_3, and the results should show values within the maxima stated above. If the section is well designed, the values of T_3 and S_3 will not be very different from those mentioned, and as before, the section will probably be excessively strong in compression.

A section taken at GH or JK would be investigated in a manner exactly similar to that used for the section EF. (See Fig. 6.) It may be expected that the section at GH will appear much stronger than necessary, but this is because it is necessary to provide a space for the main shaft to pass through, as well as for the sake of appearance. The head will need to be large to accommodate the moving parts within it, and the part of the frame immediately behind the head must not appear too small to support the head.

It is next necessary to consider a section taken at an angle, for example along the line *CD*. The free body is shown in Fig. 7. The forces will be denoted by the same letters as heretofore, but with the subscript 2.

P = the punching pressure,

P_2 = a force equal and opposite to P; P_2 is resolved into two components, L_2 and V_2,

$L_2 = P_2 \cos \alpha$ (produces uniform tension),

$V_2 = P_2 \sin \alpha$ (produces shearing stress).

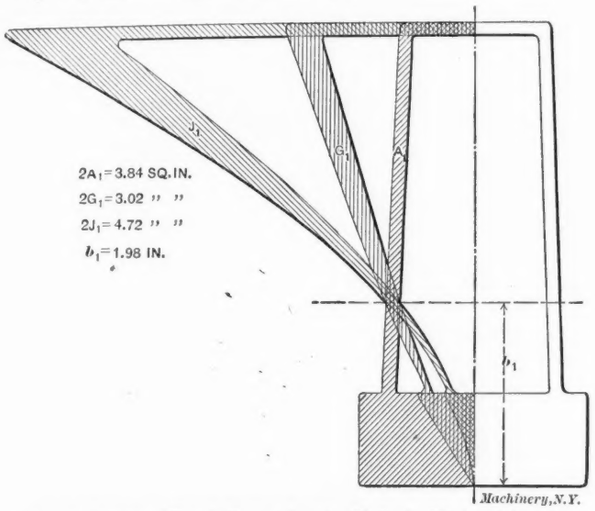


Fig. 8. Section of Punch Frame showing Method of Determining the Center of Gravity and the Moment of Inertia.

P and P_2 together form a couple which has a value $P_2 l_2 = P l_2$, which must be resisted by an internal moment, M_2.

$$M_2 = P_2 l_2 = P l_2, \qquad (20)$$

As before,

$$f_2 = \frac{M_2 e_2}{I_2} \qquad (21) \qquad c_2 = \frac{M_2 z_2}{I_2} \qquad (22)$$

$$t_2 = \frac{L_2}{A_2} \qquad (23) \qquad s_2 = \frac{V_2}{A_2} \qquad (24)$$

The maximum stresses per square inch will then be

$$T_2 = \frac{f_2 + t_2}{2} + \sqrt{{s_2}^2 + \left(\frac{f_2 + t_2}{2}\right)^2} \qquad (25)$$

$$C_2 = \frac{c_2 - t_2}{2} + \sqrt{{s_2}^2 + \left(\frac{c_2 - t_2}{2}\right)^2} \qquad (26)$$

$$S_2 = \pm \sqrt{{s_2}^2 + \left(\frac{f_2 + t_2}{2}\right)^2} \text{ or } \pm \sqrt{{s_2}^2 + \left(\frac{c_2 - t_2}{2}\right)^2} \qquad (27)$$

Take the greater of the two expressions in equation (27) for the subsequent work. This section will have dimensions between those of *AB* and *EF*.

Example of Calculation.

In order to illustrate the method of procedure outlined above, the following example is given. The machine in question is designed to punch a 1¼-inch hole in a 1-inch plate. The throat depth is 60 inches.

The punching force necessary may be found from equation (1).

$P = \pi\, dts = \pi \times 1.25 \times 1 \times 50{,}000 = 196{,}350$ pounds.

The punch frame is to be of the same general form as that shown in Fig. 3, except that the section at *JK* is to be of the same size as that at *GH*. By reference to various drawings and photographs the shape of the section at *AB* is assumed to be that shown in Fig. 8. This is drawn, in this case, on a drawing board, making the longest dimension 5.01 inches (for general practice it would be well to make the drawing larger than this, say 8 inches high), and the figures denoted by G_1 and J_1 constructed for finding the gravity axis and the moment of inertia. In this case only half of the construction is carried out, because the section is symmetrical about the vertical center line, and it will be understood that the areas measured have to be doubled before they are used in the computations, *i. e.*, the values of the areas A_1, G_1 and J_1 used in the following calculations are not the areas actually measured from the drawing as shown in Fig. 8, but twice these values, to account for the construction for the right hand side of the section which is not carried out on the drawing board. With a value of b_1 as 1.98 inch, the areas of A_1, G_1, and J_1 when measured with a planimeter are as follows:

$A_1 = 3.84$ square inches,

$G_1 = 3.02$ square inches,

$J_1 = 4.72$ square inches.

Then the values of the moment of inertia and the distance from the bottom of the figure to the gravity axis may be found through the use of equations given in the first part of this article, as follows:

$$(e_1)_d = \frac{bG_1}{A_1} = \frac{1.98 \times 3.02}{3.84} = 1.56$$

$$(z_1)_d = 5.01 - (e_1)_d = 5.01 - 1.56 = 3.45$$

$$(I_1)'_d = b^2 J_1 = (1.98)^2 \times 4.72 = 18.5$$

$$(I_1)_d = (I_1)'_d - (e_1)^2_d A_1 = 18.5 - (1.56)^2 \times 3.84 = 9.2$$

These values apply only to the figure which was drawn on the drawing board and not to the actual section. It is next necessary to find the size of the actual section. This is accomplished by assuming T_1 as 2,000 pounds per square inch and solving for X in equation (11).

$$T_1 = \frac{P_1 [K + X(e_1)_d] X(e_1)_d}{X^4 (I_1)_d} + \frac{P_1}{X_2 (A_1)_d} \qquad (11)$$

$$2000 = \frac{196{,}350\,[60 + 1.56X]\,1.56X}{X^4 \times 9.2} + \frac{196{,}350}{X^2 \times 3.84}$$

from which the value $X = 11.45$ is found by trial.

Therefore, to get the actual size of the section at *AB*, each dimension of the drawing is multiplied by 11.45. This gives the depth of the section as 57.36 inches, and also

$e_1 = 1.56 \times 11.45 = 17.86$ inches,

$z_1 = 3.45 \times 11.45 = 39.5$ inches,

and all other dimensions in the same proportions.

The value of C_1 is next calculated by equation (12) and found to be 3,420 pounds per square inch. It would seem that this is very low for a compressive stress, but the thickness of the outer part of the frame is only about 1⅝ inch, and it does not seem best to make it thinner.

After having determined the size and shape of the section *AB*, the outline of the punch is sketched in, the general shape being about as shown in Fig. 3, and care is taken to secure a form of pleasing appearance and conforming to general

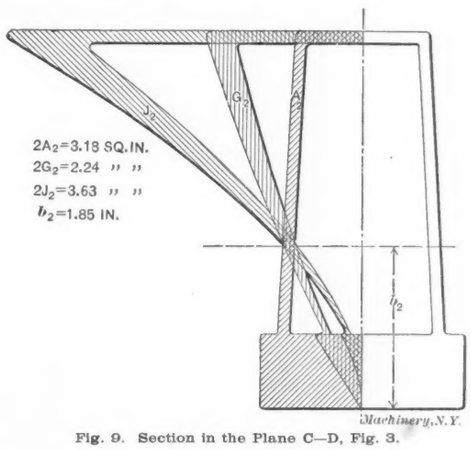


Fig. 9. Section in the Plane C—D, Fig. 3.

practice. Then drawings are made of sections at *CD*, *EF*, *GH*, and *JK*, as shown in Figs. 9, 10, and 11, using a scale $X = 12$. The constructions for finding e and z are completed as shown, and the results of the calculations for the sections are tabulated below:

Section.	A	G	J	b	e	z	I'	I
CD	3.18	2.24	3.63	1.85	1.304	2.976	12.44	7.03
EF	2.74	1.83	2.58	1.56	1.04	2.51	6.47	3.51
GH } *JK* }	2.26	1.74	2.47	1.27	0.978	2.02	3.98	1.82

The next step in the design is to investigate the stresses in the sections at *CD*, *EF*, *GH*, and *JK*. The calculations are shown below. All calculations are conveniently made with a slide rule.

Section C—D.

This section is taken at an angle $\alpha = 45°$. Then, from equations developed in the discussion of the section *CD* in the earlier part of the article, we have:

$P_2 = P = 196{,}350$ pounds.

$L_2 = P_2 \cos \alpha = 196{,}350 \times 0.707 = 138{,}700$ pounds.

$V_2 = P_2 \sin \alpha = 196{,}350 \times 0.707 = 138{,}700$ pounds.

$l_2 =$ (by measurement from drawing) 69.25 inches.

$M_2 = P_2 l_2 = 196{,}350 \times 69.25 = 13{,}600{,}000$ inch-pounds.

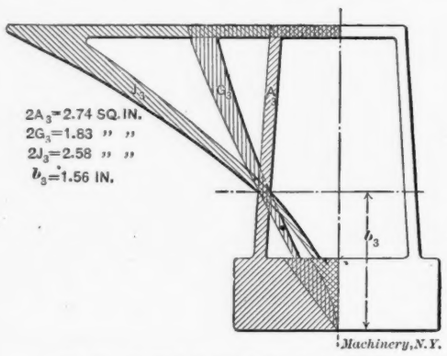


Fig. 10. Section in the Plane E—F, Fig. 3.

$$f_2 = \frac{M_2 e_2}{I_2} = \frac{13{,}600{,}000 \times 12 \times 1.304}{12^4 \times 7.03} = 1460 \text{ pounds.}$$

$$c_2 = \frac{M_2 z_2}{I_2} = \frac{13{,}600{,}000 \times 12 \times 2.976}{12^4 \times 7.03} = 3326 \text{ pounds.}$$

$$t_2 = \frac{L_2}{A_2} = \frac{138{,}700}{12^2 \times 3.18} = 303 \text{ pounds.}$$

$$s_2 = \frac{V_2}{A_2} = \frac{138{,}700}{12^2 \times 3.18} = 303 \text{ pounds.}$$

$$T_2 = \frac{1460 + 303}{2} + \sqrt{303^2 + \left(\frac{1460 + 303}{2}\right)^2} = 1811 \text{ pounds.}$$

$$C_2 = \frac{3326 - 303}{2} + \sqrt{303^2 + \left(\frac{3326 - 303}{2}\right)^2} = 3056 \text{ pounds.}$$

$$S_2 = \sqrt{303^2 + \left(\frac{3326 - 303}{2}\right)^2} = 1544 \text{ pounds.}$$

It will be noted that the tensile stress is somewhat smaller than the maximum value of 2,000 pounds per square inch which was to be allowed. However, the strength of the casting is likely to be least at this point for two reasons; first, because the section is taken at the center of a rather sharp bend for so massive a casting, and second, because of the necessity of introducing a bearing on the upper side near this section, thus requiring the frame to support the reaction from the bearing. For these reasons a lower value for the tension is not out of place.

Section E—F.

If the tabulated values of the properties of the section *EF* are substituted in the equations developed for that section, the following values of the stresses result:

$P_3 = P = 196{,}350$ pounds.

$l_3 = 54$ inches (measured from drawing).

$M_3 = P_3 l_3 = 196{,}350 \times 54 = 10{,}600{,}000$ inch-pounds.

$$f_3 = \frac{M_3 e_3}{I_3} = \frac{10{,}600{,}000 \times 12 \times 1.04}{12^4 \times 3.51} = 1815 \text{ pounds.}$$

$$c_3 = \frac{M_3 z_3}{I_3} = \frac{10{,}600{,}000 \times 12 \times 2.51}{12^4 \times 3.51} = 4380 \text{ pounds.}$$

$$s_3 = \frac{P_3}{A_3} = \frac{196{,}350}{12^2 \times 2.74} = 498 \text{ pounds.}$$

$$T_3 = \frac{1815}{2} + \sqrt{498^2 + \left(\frac{1815}{2}\right)^2} = 1944 \text{ pounds.}$$

$$C_3 = \frac{4380}{2} + \sqrt{498^2 + \left(\frac{4380}{2}\right)^2} = 4438 \text{ pounds.}$$

$$S_3 = \sqrt{498^2 + \left(\frac{4380}{2}\right)^2} = 2248 \text{ pounds.}$$

These results are all fairly near the requirements, and the section may be said to be satisfactory. The value of S_3 is a trifle higher than was originally specified; this could be reduced by increasing the area of the section slightly. The excess is, however, hardly enough to warrant this.

Sections G—H and J—K.

Sections *GH* and *JK* are practically alike in the punch under discussion, although they are not so drawn in Fig. 3. The section as shown in Fig. 3 at *GH* is nearer the size to be investigated than that at *JK*. The stresses will result as follows:

$P_4 = P = 196{,}350$ pounds.

$l_4 = 14.5$ inches (measured from drawing).

$M_4 = P_4 l_4 = 196{,}350 \times 14.5 = 2{,}850{,}000$ inch-pounds.

$$f_4 = \frac{M_4 e_4}{I_4} = \frac{2{,}850{,}000 \times 12 \times 0.978}{12^4 \times 1.82} = 885 \text{ pounds.}$$

$$c_4 = \frac{M_4 z_4}{I_4} = \frac{2{,}850{,}000 \times 12 \times 2.02}{12_4 \times 1.82} = 1830 \text{ pounds.}$$

$$s_4 = \frac{P_4}{A_4} = \frac{196{,}350}{12^2 \times 2.26} = 603 \text{ pounds.}$$

$$T_4 = \frac{885}{2} + \sqrt{603^2 + \left(\frac{885}{2}\right)^2} = 1189 \text{ pounds.}$$

$$C_4 = \frac{1830}{2} + \sqrt{603^2 + \left(\frac{1830}{2}\right)^2} = 2011 \text{ pounds.}$$

$$S_4 = \sqrt{603^2 + \left(\frac{1830}{2}\right)^2} = 1096 \text{ pounds.}$$

It is to be noted that in the case of these sections all the stresses are decidedly small. This is caused by the large section required at *GH* to provide room for the passage of the main shaft and also because a smaller section at this point would present a weak appearance as a support for the massive head. In the case of the section at *JK*, however, these reasons do not hold, and the frame in question would have been better proportioned had the section at *JK* been smaller, thus

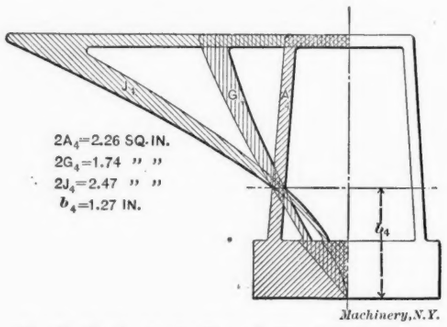


Fig. 11. Section in the Plane G—H and J—K, Fig. 3.

making the stresses more nearly equal over the entire frame. The punch frame illustrated in Fig. 3 is better proportioned in this respect.

The system of design here presented may be applied to frames of many other forms of machines besides punching and shearing machines. It offers the following advantages:

1. It is mathematically correct in principle.
2. The sources of error are comparatively small and are of a kind easily detected.
3. The graphical constructions involved are not laborious, and are sufficiently exact for any ordinary work. The degree of accuracy can be increased at will by employing larger scales.
4. Considerable latitude is allowed for the judgment of the designer.

GEAR-CUTTING MACHINERY—8.

RALPH E. FLANDERS.*

This installment of this series of articles continues the discussion of machines for cutting the teeth of bevel gears, the particular type under discussion being that operating on the templet principle.

Fig. 155 shows a machine of this type, built by the firm (Société Suisse pour la Construction de Machines-Outils Oerlikon, Oerlikon près Zurich, Switzerland) which designed the one last described. The writer has little definite information in regard to this machine. The head carrying the slides is fed inward about a vertical axis, as in the Gleason machine. The swiveling movement of the tool slide about the horizontal axis is also similar to the Gleason machine, but the two are differentiated in their action by the provision of a second slide and tool-holder, both pivoting about the same horizontal axis. The movement which the templet imparts to the upper slide is duplicated on the lower one, though in the reverse direction, so that the outlines formed on each side of the tooth are symmetrical. Besides the use of the two tool slides, this machine also differs from the Gleason in having the head carrying the work spindle and the automatic indexing mechanism, swivel for adjusting to the angle of the work, about the same vertical axis around which the feeding movement of the cutter slide head takes place. This tool was designed by its builders to provide a maximum of accuracy and rapidity for work within its range.

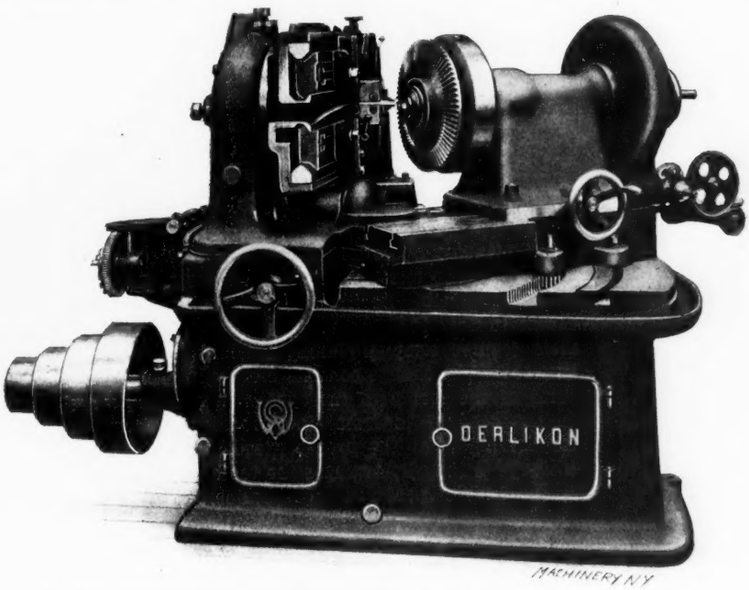


Fig. 155. Oerlikon Bevel Gear Cutter operating on the Templet Principle, and using Two Tools Simultaneously.

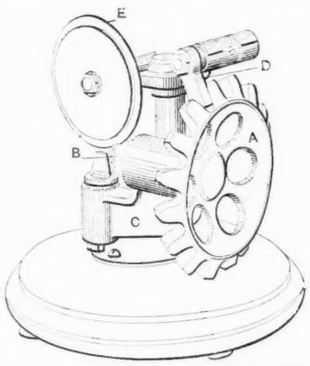


Fig. 156. Model showing the Principle of the Rice Machine shown in Fig 157.

In Fig. 156 is shown the principle of a templet bevel gear planing machine differing in many respects from any of those previously shown. This principle originated with Mr. Charles DeLos Rice, of Hartford, Conn., and the machine he designed, incorporating it, is much used for cutting chainless bicycle gears, though it is not now on the market. The differences consist principally in the form of templet used, and in the form of the follower and the cutting edge of the tool. In other templet machines the follower which makes contact with the templet is presumably a point, as should also be (to insure theoretical exactness) the cutting point of the tool. In reality, of course, the outlines of both these members are rounded, a roll being generally employed for making the contact with the templet, and a round-nose tool being used for doing the cutting. Theoretical accuracy could be obtained under these conditions if the shape of the templet were made to allow for the diameter of the roller which follows it (as is the case in making templets for the Gleason machine, at least) and if the shape of the point of the tool is also considered. The latter, however, should grow continuously smaller as it approaches the small end of the tooth, in the same scale with the decrease in size of the tooth itself, and similarly, it should grow larger as it approaches the large end. As it, of course, remains the same size all the time, a slight error is introduced—so slight, however, as not to introduce anything except a negligible inaccuracy.

In the Rice machine the copying of the former is done with theoretical precision. Both the guiding and the cutting edges are plane surfaces, and being such, obviate the necessity for a change of scale in cutting outlines at different points of the stroke. Fig. 156 shows a model of the movement employed, especially made for the purpose of illustration. The templet *A*, used, is a complete gear of the same proportions as the work to be cut, but on a larger scale. It is mounted on a spindle fast to the blanks *B*. This spindle is carried by a swinging bracket *C*, pivoted about an axis at right angles to that of the work, and passing through the apex of the pitch cone of the work and master gear. The sketch of the model shows a disk *E* mounted on a fixed horizontal spindle, entering one of the spaces which have been cut in the blank. The acting surface of the disk is in the plane of the vertical axis about which bracket *C* swings. In the same plane is the acting surface of a fixed stop or guide plate *D*, which, as shown, is mounted on the same pedestal as the spindle of the disk and enters the space cut in the master gear in the same way that the disk enters the space between the teeth of the work.

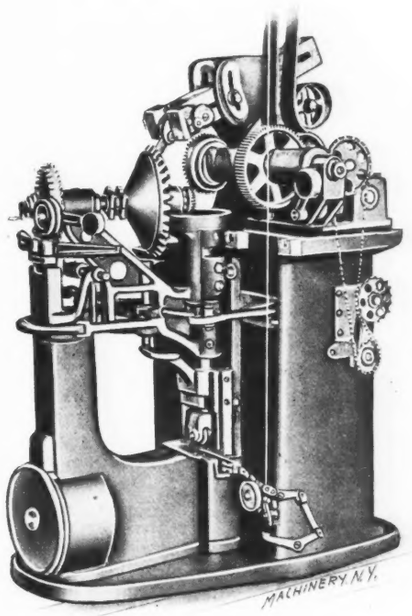


Fig. 157. The Rice Bevel Gear Milling Machine, which Forms the Teeth from a Master Gear on the Templet Principle.

If the teeth of the master gear be pressed against the acting side of the fixed stop, while the bracket supporting the master gear and the work is rocked about its vertical axis, it is evident that the stop will roll about the face of the tooth

* Associate Editor of MACHINERY.

of the master gear or templet, making line contact with it, while the face of the disk will act in an identical manner, though on a smaller scale, with relation to the tooth of the work. If the disk be replaced with a cutter of the same diameter, and with a cutting face in the same plane as that occupied by the acting face of the disk, the rocking of the bracket about its vertical axis will evidently cause the cutter to mill out a tooth face identical with that of the templet or master gear, but on a smaller scale. While this operation appears to

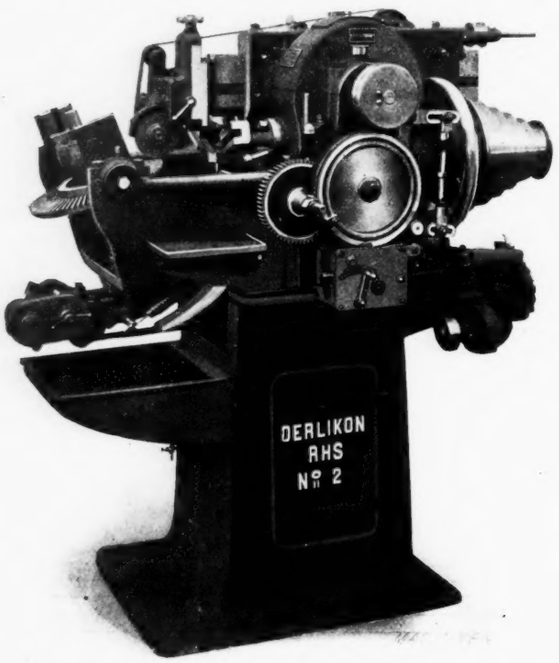


Fig. 158. The Oerlikon Templet Gear Shaper of Fig. 154, arranged with Grinding Wheel for Finishing Hardened Bevel Gears.

have the ear marks of the generating process, it operates on the templet principle in reality, as is shown by the description we have just given. The cutter is made of large diameter, as compared with the work, in order to give as straight a bottom to the tooth space as possible. The deepening of the tooth space in the center does not, of course, affect the accuracy of the working portion of the outline.

An automatic machine in which these principles are embodied is shown in Fig. 157. The mechanism is too intricate to be described without the use of a considerable number of line drawings and an extended description, so we will content ourselves with enumerating the movements which the mechanism effects. The master gear governs the tooth spacing, the tooth thickness and the tooth form. The master gear and a previously-gashed blank being mounted in position in the machine with the guide plate and cutter positions and other adjustments properly made, the mechanism is started. The cam movements provided first feed the master gear and work spindle upward until the cutter is in to depth and the stop bears against the face of the master gear. The bracket carrying them is then rotated about its vertical axis until one face of one tooth of the blank is completed. The work is now dropped down out of the way, and the spindle, with the blank and master wheel, are indexed one revolution, after which they are again raised, repeating the same operations as before. This is done repeatedly until the whole gear has been cut around on one side of all the teeth. When this has been done, the machine stops and the attendant rotates the segment of a hand-wheel rim seen encircling the front pillar of the machine. Through the link connections on this rim, the fixed gage and the cutter are each shifted axially a distance equal to their thickness, so as to bring them to positions to work on the other side of the tooth. The automatic mechanism for swinging the work spindle is also changed by the same movement, so that it swings in the other direction. The mechanism is then started up and the other sides of all the teeth are finished.

An interesting point in the product of this machine is that the gears produced are accurate copies of the master gear on a smaller scale. It is thus possible where bevel gears are to be made in large quantities, to make the master gear and pinion, and run them together under conditions severe enough to test their suitability for the work the smaller gears are to perform. Such corrections as may be required being made in these large gears, assurance is given that the smaller gears will behave in a satisfactory way. The principle of this machine could, of course, be adapted to a machine for general use, by using as a templet but a single tooth of the master gear, instead of employing an entire wheel, as here shown. It was at one time, we are informed, the intention of the inventor to develop such a machine, but so far this has not been done commercially. Obviously, this method of applying the templet principle cannot be applied to teeth having concave surfaces.

Machines Employing the Templet Principle for Grinding the Teeth of Bevel Gears.

The grinding operation has been used in a templet machine built by the Société Suisse pour la Construction de Machines-Outils Oerlikon, Oerlikon près Zurich, Switzerland and shown in Fig. 158. As may be seen, it is a modification of their regular templet planing machine, previously shown in Fig. 154. The change consists merely in replacing the cutting point of the tool with the edge of a grinding wheel, carried on the head of the ram, and provided with suitable means for driving it at the proper speed. Under these conditions, the edge of the wheel shapes the teeth of the gear to the form of the templet provided. The builders state that by the employment of special wheels which they have developed for

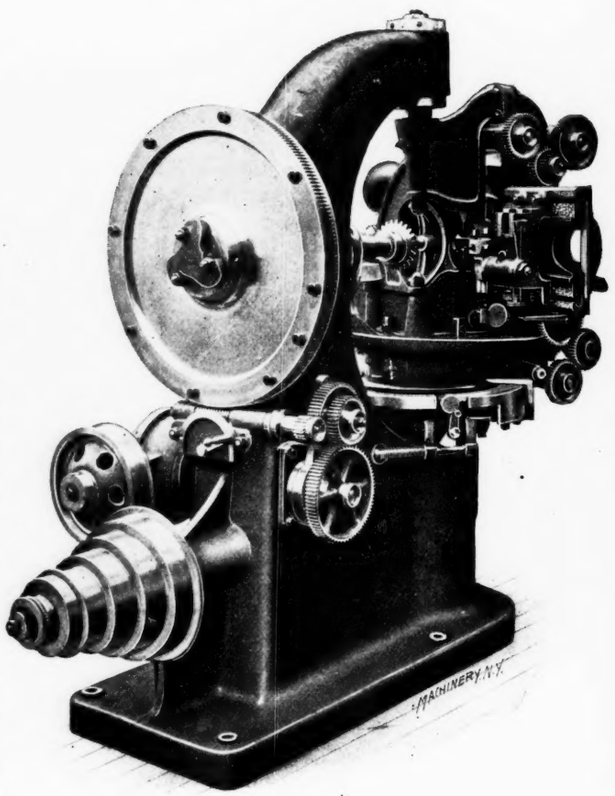


Fig. 159. The Dubosc Bevel Gear Planing Machine, cutting Involute Teeth by the Odontographic Principle.

the purpose, it is possible to cut clear around a large gear without a perceptible change in the condition of the cutting edge, or a corresponding change in the profile of the tooth produced. If this is so, the greatest objection to the grinding process for gear cutting of any kind is largely obviated. The purpose of the machine is, of course, the finishing of the teeth of hardened gears to remove the inevitable inaccuracies due to distortion arising from the heat treatment. It has been found especially useful in automobile work.

This Swiss firm has done especially noteworthy work in the building of machines for cutting bevel gears. The three we have illustrated, Figs. 154, 155 and 158, and one we will show later for milling bevel gears by the molding-generating principle, do not by any means exhaust their list of machines built for forming the teeth of gears of this type. Among other

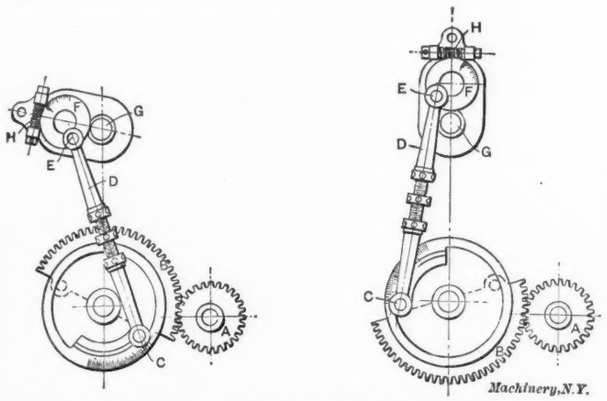


Fig. 160. The Odontographic Mechanism of the Dubosc Machine at the Beginning and End of the Cutting Action.

Oerlikon designs may be mentioned two of great interest, described in a paper by Mr. Fred. J. Miller, to be found in Vol. 22 of the Transactions of the American Society of Mechanical Engineers.

Machines Working on the Odontographic Principle for Cutting the Teeth of Bevel Gears.

A machine operating on the odontographic principle, in which the point of the tool is guided by mechanism which very nearly reproduces the theoretical shape, is shown in Fig. 159. It is built by Officina Meccanica Ing. E. Dubosc, Via Principi d'Acaia, 62, Turin, Italy. In this machine, as may be seen, the work spindle is horizontal and is indexed by a dividing wheel of large diameter. The work arbor is supported at the outer end in a stirrup held in the swinging tool frame, this support making it possible to do heavy and rapid cutting. The work is adjusted by means of suitable gages until the apex of its pitch cone lies in the center line of the journals provided at the top and bottom of the main casting of the machine for the trunnions of the frame which swings about the work in a vertical axis. This frame carries most of the mechanism of the machine, and is provided with pivots in a horizontal axis, in the same plane with the vertical axis, about which swings a counterbalanced arm having guides for the tool slide. A tool may thus be set to have a reciprocating movement in any plane, toward and away from a point coinciding with the apex of the pitch cone of the work. This being the case, if suitable mechanism for effecting it is provided, the tool may be made to plane a conical surface, vanishing at the center of the horizontal and vertical axes, and determined by any line drawn on the surface of a sphere having the same center. In this respect it resembles all templet and odontographic machines, which are distinguished from each other only in the means provided for guiding the tool, as shown in Figs. 136 and 137.

In the machine in question, the odontographic mechanism provided produces teeth of involute form. This mechanism (which is obscured in Fig. 159) is shown in diagrammatic form in Fig. 160, in two positions. We cannot take the space here to describe why the mechanism produces a curve of almost absolutely true involute form, nor can we enter into the details of the connections by which the movements effected by this mechanism are transferred to the point of the tool, as this would require an article in itself. It can only be said the pinion A is connected with a worm meshing with a segment of a worm-wheel fast to the base of the machine, by means of which the frame carrying the mechanism and the tool is rotated about its vertical axis. This pinion meshes with the segmental gear B, which carries a crank-pin C, angularly adjustable for a certain amount about the center of the gear. A connecting-rod D, adjustable for length, connects crank-pin C with a second pin E attached eccentrically to a disk F, eccentrically seated in turn in a crank whose center is G. Disk F, with crank-pin E, may be adjusted for various angular positions about the center of the disk by worm H. Crank G is connected with mechanism for swinging the tool slide in a vertical plane about its vertical axis, the whole mechanism thus serving to connect the movements of the tool about the horizontal and vertical axes. By setting C according to graduations at various angular positions with relation to B, and by setting E at various positions by the rotating of disk F, and by adjusting the length of connecting-rod D, the movements about the horizontal and vertical axes may be so connected as to produce tooth outlines of correct forms.

This apparatus, as described, determines the form of the tooth. Change gears provided between G and the vertical movement which it accomplishes, and A and the horizontal movement with which it is connected, alter the scale of the outline—that is, adapt it to a large tooth or a small tooth as may be required. Still other change gears are provided for the indexing, which is automatic, as are all the functions of the machine for completely forming one side of all the teeth of the gear. When this has been done, the machine is reversed for cutting the other sides of the teeth. The shape that can be given varies from the straight side of the rack tooth (which is used for all gears having more than 150 teeth), to small bevel pinions with undercut flanks in which a reverse motion has to be given to the movement about the horizontal axis. The tool is provided with mechanism for cutting on both the forward and back stroke on work that is large enough to admit this.

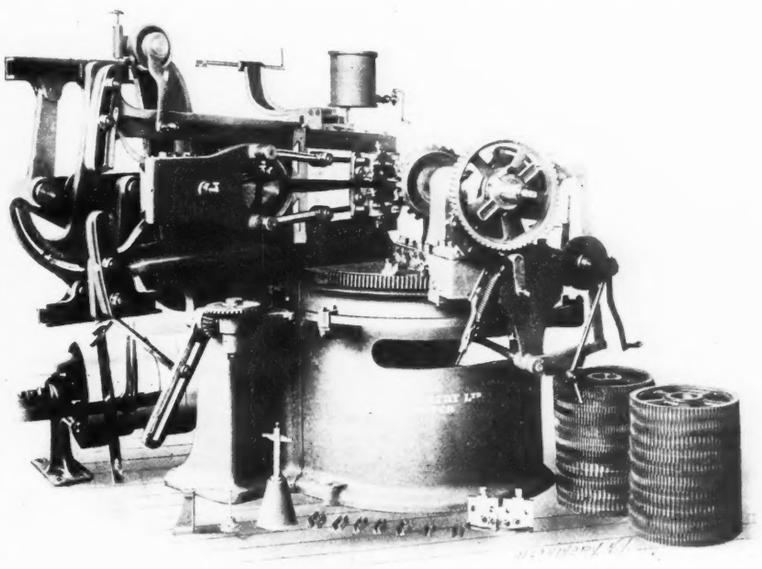


Fig. 161. The Smith & Coventry Odontographic Bevel Gear Planing Machine.

We are informed by the English licensees of the Dubosc patents, Messrs. Selig Sonnenthal & Co., 85 Queen Victoria St., E. C., London, England, that the builders of the tool are preparing a new design, embodying a number of improvements in the mechanism. We hope to be able to describe this new machine at some later time. The machine is ordinarily furnished for cutting involute bevel gears, having a pressure angle of 22½ degrees, this being the usual angle for automobile work. It can be made to order, however, for cutting other angles as desired.

The only other odontographic machine the writer is acquainted with is built by Smith & Coventry, of Manchester, England (see Figs. 161 and 162). It is somewhat easier to

understand than the Dubosc machine, as the curves it employs are simple arcs ot circles. Two tools T_1 and T_2 are used, each set in separate slides S_1 and S_2 pivoted about an axis at the apex X of the pitch cone of the blank being cut. These slides have rearward extensions in the form of arms A_1 A_2, ending in slotted arcs concentric with axis X. Each of these arms is clamped by bolts passing through the slotted arcs to blocks C_1 and C_2 sliding in horizontal guides on parallel bars D_1 and D_2. Bar D_1 is supported on links E and E_1, while bar D_2, pivoted also to double ended link E, is supported by it and short link E_2. As link E is rocked, the

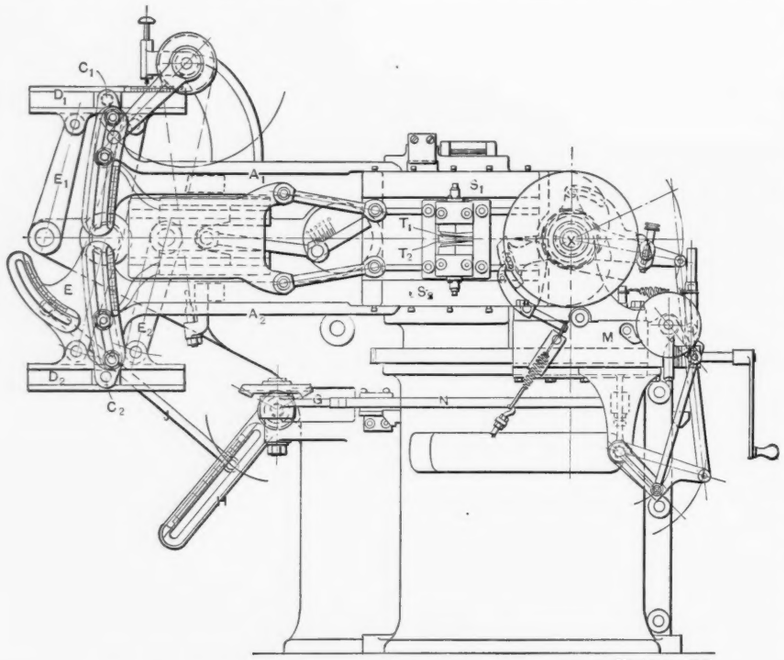


Fig. 162. The Mechanism of the Smith & Coventry Bevel Gear Planer.

two bars swing, one to the left and upward and the other to the right and downward, but with their guiding surfaces always parallel. As they are swung in this way, the two slides A_1 and A_2 are brought together or opened out, as the case may be.

The rocking of this parallel linkage system is effected by a connection with the angularly adjustable head M, which carries the work spindle. This is swung inward for the feeding movement to shift the tools down the sides of the tooth until the full depth has been reached. To slide M is clamped a circular bar N, whose rear end has teeth cut in it engaging with those of a sector G, which, by the bevel gearing shown, is connected with slotted arm H. This arm is adjustably connected with link E by a connecting-rod J, which, as shown, may be altered slightly as to length and to the amount of movement given it, depending on the way in which it is clamped to H. From this it will be seen that as the work slide M swings around, moving the teeth of the blank inward toward the tools, its connection with circular bar N through sector G, and the geared connections of the latter with arm H, operate the linkage system E, E_1, E_2, and bars D_1 and D_2, with the tool-slides S_1 and S_2 connected with them. By this means the tools are gradually opened out as the base of the tooth is approached, in such a way as to make their outlines correspond to circular arcs approximate to the desired involutes, the circular form being determined by the swinging of the links E_1 and E_2 about their centers. Tables are furnished for setting J with relation to H, and arms A_1 and A_2 with relation to D_1 and D_2, so as to reproduce on the teeth the proper outlines.

It should have been mentioned that this machine does not work on the principle of completing one tooth, and then indexing to complete the next. The work indexes at every stroke of the double tools. After the first cut has been taken on the first tooth, the work is indexed and the same cut taken on the next tooth. When the work has been once around in this way, the tool starts in with a deeper cut on the first tooth again, this continuous rotation and gradual feeding in of the tool continuing until all have been simultaneously formed to the required depth and proper shape, being similar in this respect to the Bouhey machine in Fig. 152.

A Machine Operating on the Molding-Generating Principle and Employing the Impression Operation.

In Fig. 163 is shown the only example known to the writer of a commercial machine operating on the molding-generating principle. This machine was built by the Brown & Sharpe Mfg. Co., Providence, R. I., for performing the finishing and correcting operations on bevel gears, roughed out in the special full automatic formed-cutter machine, previously described, and shown in Fig. 146. It is not, therefore, a machine which finishes the gear directly from the blank. The impression process is, of course, absolutely impracticable for operations that would require the pressing into shape of as much metal as would be required in that case.

The machine contains two spindles, of which the one carrying the forming gear is driven by suitable belts and pulleys from the counter-shaft, while the other spindle is mounted in a head which, as shown, can be set at any angle with the first, to agree with the angle between the axes of the forming gear and the work being pressed into shape. The forming gear, instead of being a small pinion, as in Fig. 138, is a crown gear; this gear is chosen on account of the facility with which it can be accurately made, the sides of the teeth in the system employed being plane surfaces, as described in connection with Figs. 139 and 140. In the final operation, a forming gear thus correctly made and hardened so as to resist the wear brought to bear on it, is mounted on the belt-driven spindle and brought into proper engagement with the roughly formed gear mounted on the other spindle. The machine is started up and the two are revolved together. The mechanism provided is such that the pair run in one direction for a certain number of revolutions and then reverse and run in the other direction, repeating the process as long as the machine is in operation. Meanwhile a cam mechanism operates to jam

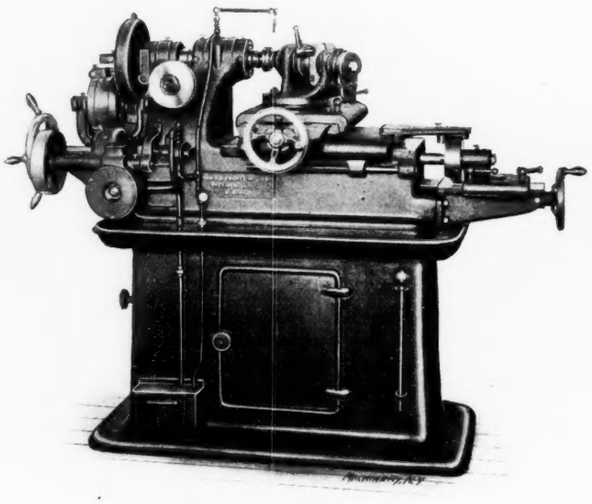


Fig. 163. Brown & Sharpe Machine for Correcting Bevel Gears by the Molding-Generating Principle, employing the Impression Process.

the blank and forming gear together, relieve the pressure for a short space and jam them together again, repeating the process continuously. By this means the hardened surface of the forming crown gear presses out the inaccuracies in the work and smooths the surfaces of its teeth.

The operation we have just described is the final one, however, and does little more than burnish the teeth. The same machine is used for a preliminary operation which does most of the work of smoothing out the inaccuracies of the formed cutter process. This employs the same movements in the machine, but uses a different form of crown gear, shown in action in Fig. 164. As may be seen, the successive teeth are cut off at different heights. The edges thus formed where

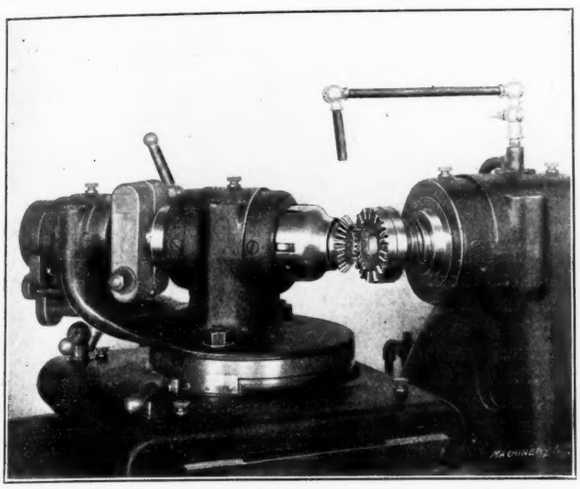


Fig. 164. Near View of the Tool and the Work in the Machine shown in Fig. 163.

the teeth are cut off, dig into the roughed out teeth of the work and remove the metal from the high spots, while they pass freely and without action over the parts of the teeth which are of the correct contour. Being of so many different heights the whole face of each tooth of the work is acted on, though, of course, this is the case only when the number of teeth in the work and in the crown gear do not have a large common factor. In the bicycle trade for which these machines were developed, the gears were so designed that this contingency did not arise.

Machines Operating on the Molding-Generating Principle, and Employing the Planing or Shaping Operation.

The mechanism illustrated in outline in Fig. 139 is one that has been employed in a number of exceedingly interesting and ingenious machines. The first application of this principle was made by Mr. Hugo Bilgram, 1231 Spring Garden Ave., Philadelphia, Pa. His form of machine has been used for a

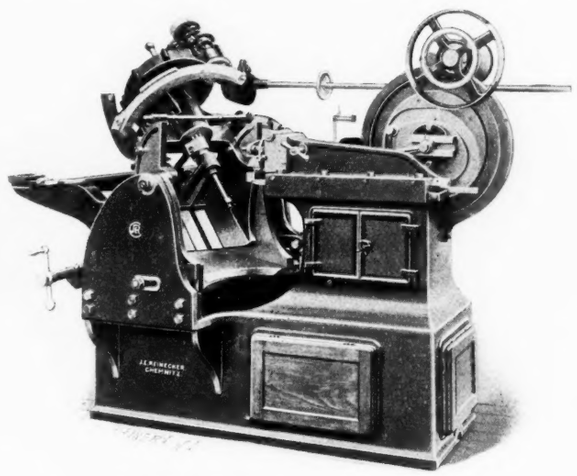


Fig. 165. Bilgram Bevel Gear Shaper as built by J. E. Reinecker.

great many years, and produces work whose accuracy has almost become proverbial. An example of this machine, built under Mr. Bilgram's patents by J. E. Reinecker, of Chemnitz-Gablenz, Germany, is shown in Fig. 165. The movements operate on the same principle as that in Fig. 139, but in one of the modified forms explained in the text accompanying that figure. That is to say, instead of rotating the crown gear and master gear together, the imaginary crown gear and, consequently, the tool, remain stationary so far as angular position is concerned, while the frame is rotated about the axis of the crown gear, thus rolling the master gear on the latter and rolling the work in proper relation to the tool. Instead of using crown and master gears, however, a section of the pitch cone of the master gear is used, which rolls on a plane surface, representing the pitch surface of the crown gear. The two surfaces are prevented from slipping on each other by a pair of steel tapes, stretched so as to make the movement positive, in something the same way as shown in Fig. 4. A still further change consists in extending the work arbor down beyond center *O* in Fig. 139, mounting the blank on the other side of the center so that the tool, being also on the other side of the center, is turned the other side up from that shown in the diagram. All these movements can be followed in Fig. 165. As explained, a tool with a straight edge is used, representing the side of a rack tooth, and this tool is reciprocated by a slotted crank, adjustable to vary the length of the stroke, and driven by a Whitworth quick return movement. The feed of the machine is effected by swinging the frame in which the work spindle and its supports are hung, about the vertical axis of the imaginary crown gear.

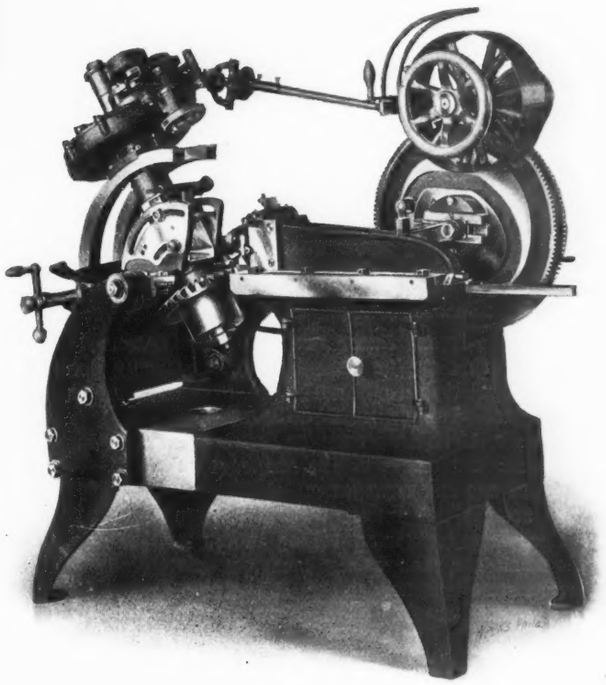


Fig. 166. Full Automatic Bilgram Bevel Gear Shaper, working on the Molding-Generating Principle.

Suitable feed connections, index mechanisms, etc., are provided for convenient operation.

In Fig. 166 is shown a development of this tool, in which the motions are completely automatic. The example illustrated is built and sold by Mr. Bilgram himself. In this case, the operator sets the machine and places a previously-gashed blank on the work spindle and starts the tool in operation. The mechanism provided will, without further attention, complete one side of all the teeth. The machine may be then readjusted and the tool set for cutting the other side, which will be finished in the same automatic fashion. The mechanism does not operate on the principle of completing one side of one tooth before going to the next. It follows the plan adopted by the same builder in his spur and spiral planing machines shown in Figs. 48 and 95, in which the work is indexed for each stroke of the tool, the rolling action being progressive with the indexing so as to finish all the teeth at once. A little thought will show that these three Bilgram machines are identical in principle, with only the modifications required to fit that principle to the making of spur, spiral, and bevel gears, respectively. The bevel gear machine is the only one that has come into extensive use, since the

bevel gear is the only one of the three kinds in which there is any great difficulty in forming the teeth accurately enough for all practical purposes.

Another machine operating on the same principle as the Bilgram is that built by the Ateliers de Constructions

Fig. 167. Ducommun Bevel Gear Generator operating Two Tools.

Mecaniques ci-devant Ducommun, Mulhouse (Alsace). (See Fig. 167.) This machine has been so thoroughly described in MACHINERY* that it will not be necessary to go into minute details here. The principal differences between it and the Bilgram machine (aside from the obvious differences of the shape of the framework and the arrangement of the mechanism) are the link motion used in place of the steel tape for giving rolling movement to the blank, and the provision made for using two tools simultaneously so that both sides of a tooth are finished at once. This machine is not, like the last Bilgram machine described, fully automatic, but is arranged to cut a side of one tooth, after which it is indexed by hand and the side of another tooth cut.

The two tools are each carried in slides of their own, in the center of the circular top of the table. These slides are independently adjusted to bring the movement of the straight cutting edges in line with the plane surfaces of the teeth of the imaginary crown gear of Fig. 139. As in the Bilgram machine, the tool slides are stationary, while the frame carrying the work spindle is revolved about the vertical axis of the crown gear, a tooth of which is represented by the cutting edges of the tool. The swiveling movement of this frame is effected by a sector of a worm-wheel fastened to the circular table on which the frame is mounted. Suitable feeding movements and automatic stops are provided. To roll the blank with the same movement as a master gear rolling with the imaginary crown gear, a circular link, as shown, is clamped at the upper end to the spindle and the dividing mechanism, so that these parts and the work can be rocked by it about their axis. The lower end of this link is controlled by other curved links in such a way that the rolling movement produced on the blank as the circular table is rotated about its vertical axis, is nearly exactly the theoretical movement required. The interesting way in which this is effected has been explained at length in the article previously referred to. The arrangement of the links controlling the rolling movement of the blank shows very plainly the spherical basis of the bevel gear, as illustrated in Fig. 133. This is one of the most interesting of the bevel gear generating machines, and gives evidence of designing ability of a high order.

A French machine of the type we have been considering, built by H. Ernault, 169 Rue d'Alésia, Paris, is shown in Fig. 168. It was designed by Monsieur Monneret, and shown at the Paris exhibition in 1900. The writer is not sure that it is being manufactured for the trade at the present time. It is of such interest, however, as to warrant illustration and description.

This machine is identical in its operation with the typical mechanism shown in Fig. 139, in that the axes of the work and of the imaginary crown gear are fixed in position, and are rotated in the proper ratio with each other to give the desired rolling movement of the tool and the blank on each other. The cutter slide is mounted on what resembles the head-stock of a lathe, at the right-hand side of the machine in Fig. 168. It is driven by a crank seen through the opening at the front of the slide. The tool is carried on the holder at the back upper end of the slide, and is provided with automatic means for positively relieving it on the back stroke.

To understand how this tool slide is rolled about its axis in unison with the rolling of the blank, it is first necessary to state that this machine will cut helical gears only, this being due to the fact that the crank-shaft and the blank are connected positively by change gearing, so that the blank rotates continuously, resembling in this particular the arrangement provided on the Bouhey machine for making, when required, gears of this kind by the templet process. Unlike the Bouhey machine, however, the one we are describing cannot be used for making straight tooth bevel gears; and, since the blank has to have imposed upon it a

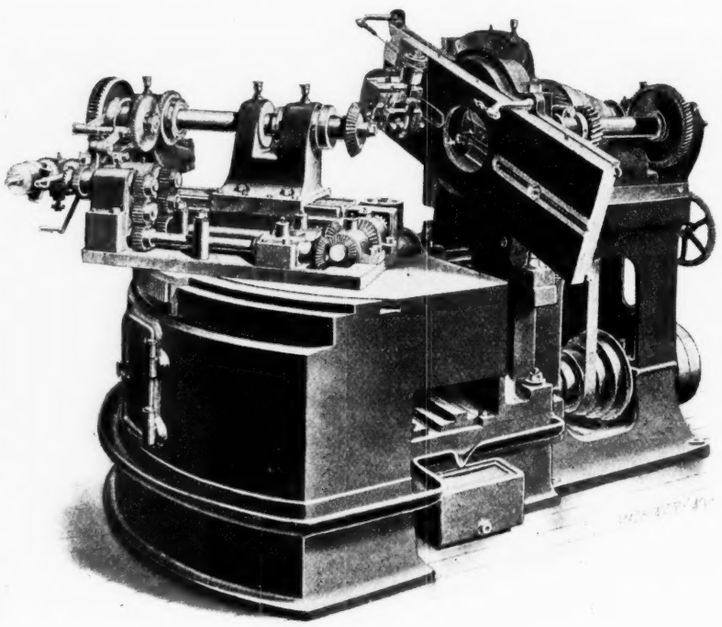


Fig. 168. The Ernault Bevel Gear Generating Machine, which cuts Gears with Helical Teeth.

rotary motion in unison with the rolling of the tool-slide, and in addition to the rotating motion due to its connection through the change gears with the tool-slide crank-shaft, a differential movement has to be introduced for combining the two.

The change gears set for the number of teeth connect the crank-shaft and the indexing worm at the rear of the work

*See article "A European Bevel Gear Generating Machine" in the January, 1907, issue of MACHINERY.

spindle through a train of positive gearing and shafts The rolling movement of the blank (and of the tool slide about its axis) is driven by a cam and ratchet movement operated by the spur gearing leading from the work spindle at the left of the machine in the engraving. This ratchet-driven motion is connected by bevel gears with a screw which shifts, in the direction of its axis, a cradle or yoke in which is confined the index worm for giving the rotary movement to the blank. This worm is splined upon its shaft, so that it transmits to the work through its longitudinal motion a rolling movement derived from the ratchet feed, and a continuous rotary movement derived from the change gearing and the crank-shaft. These movements are combined without interfering with each other, and either may be started or reversed independently. It will be seen that the mechanism is exactly identical in principle with that described for the Reinecker worm gear hobbing machine in Fig. 128.

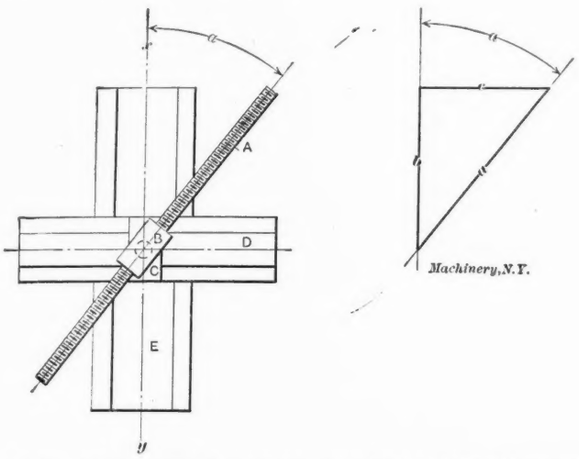


Fig. 169. The Mechanism by which the Proper Ratio of Rolling Movement for the Blank and Tool is obtained for the Machine in Fig. 168.

The same ratchet mechanism that shifts the indexing worm axially is connected by the train of gearing shown with a vertical shaft passing down through the center of the angular adjustment of the work slide, where it is connected with a screw, shown diagrammatically at *A* in Fig. 169. This screw is supported in bearings connected with the work slide in such a way that, as the latter is adjusted to the angle of the gear being cut, the screw is swiveled with it, being always at right angles to the axis of the work spindle. The nut *B*, which encircles this screw, is pivoted to a sliding block *C*, which is dove-tailed to slide *D*. *D* in turn slides in guiding ways *E* in the direction *xy*. Slide *D* is fastened to a rack meshing with a pinion, connected by shaft and gearing with mechanism for rocking the tool slide, the whole arrangement furnishing the means by which the rolling of the blank effects the corresponding rolling of the imaginary crown gear and the work, in unison.

The ingenious feature of the mechanism in Fig. 169 is the way in which the proper ratio of movement for the rolling of the work and the tool is assured. When the axis of the work and of the imaginary crown gear are set in the same straight line, as would be required when cutting a crown gear, the axis of screw *A* is by that setting shifted until it is parallel with *xy*, and thus the movement of *D* on *xy* is the same as that of the nut *B* along the screw. If, on the other hand, the work spindle is adjusted to angle *a* with the axis of the crown gear, the mechanism will take the position shown in the engraving, and the screw, when moving the nut a distance *a*, will move slide *D* on ways *E* a smaller distance *b*, resolving the motion *a* into two components, *b* and *c*. Of these two, *b* is in exactly the right proportion to *a* to give the rolling movement required for the tool, and it is transmitted to the tool slide by the motion described. This, it will be seen, does away with the necessity for adjusting the rolling movements separately as required for the Bilgram and Ducommon machines.

In Fig. 170 is shown an American machine* of the molding-generating type, employing the planing or shaping operations. It differs from the previous machines of this kind we have described, in employing two tools, one on each side of the tooth, resembling in this respect the Oerlikon templet planer shown in Fig. 155. This tool is identical with the previous one and with the mechanism in Fig. 139, in having the axes of the tool slides and of the blank fixed in relation to each other during the operation, the tool-holders and the blank rocking about their axes to give the rolling movement for cutting. The connections, however, between the blank and the slide are entirely different, and the tools finish each tooth of the work complete before they commence on another. The rocking is effected (in the recent improved form, not shown below) by means of segments of an actual crown gear and master gear. The segment of the crown gear is permanently attached to the face of the rear of the cutter slide frame, while the segment of the master gear (of which there are several furnished with the machine, the one used being chosen to agree with the angle of the gear to be cut) is clamped to the semi-circular arm pivoted at the outer end of the machine at one side, and fastened to the work spindle sleeve on the other. This arm is rocked by a cam mechanism and slotted link at side opposite that shown in illustration.

The cycle of operations is as follows: The machine being adjusted properly in its preliminary position, the tool slide and the head on which it is mounted are swung back about the vertical axis so that the tools clear the work. The blank being set in the proper position, a cam movement swings the cutter slide head inward until the tools reach the proper depth. The cam movement first mentioned now rocks the semi-circular arm extending around the front of the machine upward, rolling the blank and (through the segmental crown and master gears) the slide, until the tools have been rolled out of contact in one direction, partially forming the teeth as they do so. The arm is then rolled back to the central position and along downward to the lower position, until the tools are rolled out of contact with the tooth in this direction, completing the forming of the proper shape as they do so. The cam then rocks the arm back to the central position, where the cutter-slide head is swung back to clear the tooth, and the work is indexed, after which this cycle of operations is continued for the next tooth. It will be seen that by starting from the central position, going to each extreme and re-

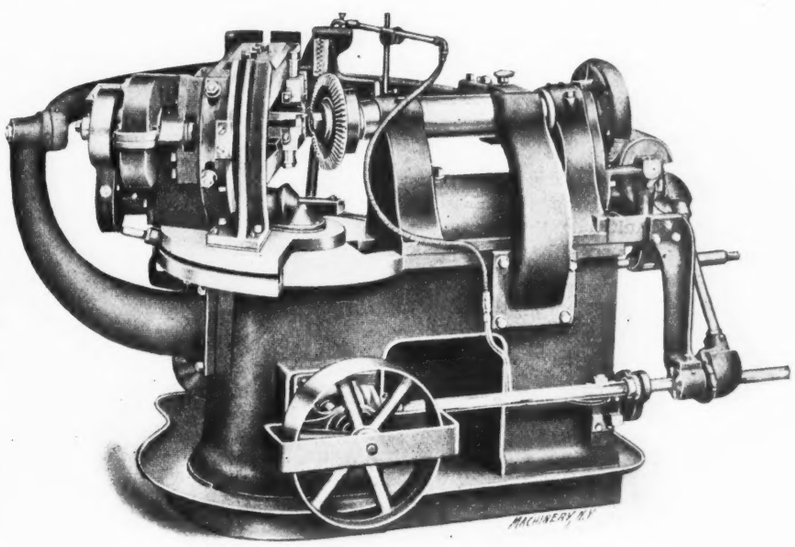


Fig. 170. The Gleason Bevel Gear Generating Machine as first developed.

*See article "The Gleason Generating Bevel Gear Planer" in the July, 1906, issue of MACHINERY.

turning, all parts of each tooth are passed over twice, giving a roughing and a finishing chip.

The machine is entirely automatic. The use of two tools presents a number of advantages. Not only does it increase the rate of working, but it balances the thrust of the cutting action of the two sides of the teeth and reduces chatter and vibration, thus giving greater accuracy. The slides of each of the two tools, of course, have to be relatively adjusted to each other, depending on the size of the tooth being cut.

* * *

A GREAT PUBLIC CLOCK.

CHARLES A. BRASSLER.*

The famous clocks of the old world, with their complicated mechanisms, telling of the movements of the planets, their crowing cocks, and processions of figures representing historical celebrities or biblical subjects, interesting as they are

Fig. 1. Great Clock on Factory of Colgate & Co., Jersey City, N. J.

to the antiquarian and curiosity seeker, could find little place in the practical up-to-date United States. On the other hand, a time-piece that will be a mentor to busy thousands in the great mercantile center of the new world, and a land-mark for the voyaging multitude that annually enters and leaves its portals, possesses more than passing interest.

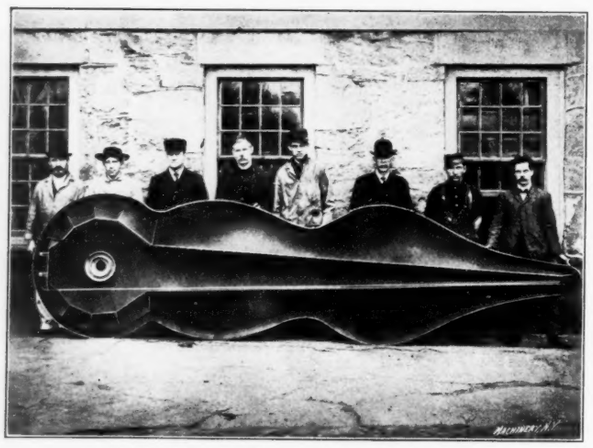


Fig. 2. View showing Great Size of Hour Hand.

Such a clock has been installed by the firm of Colgate & Co., manufacturers of perfumery, soaps, etc., on the roof of their great factory in Jersey City, and our readers will doubtless be interested in some of the dimensions of this gigantic time-piece, by far the largest in the world. The dial is 40 feet 6 inches in diameter, compared with the 37½-foot dial of the church of St. Rombaut at Mechlin (French-Malines), Belgium, hitherto regarded as the largest in the world. The marks used instead of numerals on the Colgate clock are 5 feet long and 30 inches wide.

While this clock is plainly visible and its record easily legible by day from the tall buildings in lower New York and from the decks of the crowded ferry-boats with which the Hudson River is at all times filled, it is after dark that the clock is most conspicuous. Innumerable electric lamps placed in deep grooves to concentrate their light, illuminate the figures on the dial, while the moving hands carry around with them a sufficient number of incandescent lamps to brightly outline them. Forty-two lamps light up the minute hand, which measures 20 feet from hub to tip, and without its counterbalance (which latter weighs 270 pounds) weighs 640 pounds, while twenty-five lamps will outline the hour hand, which is 15 feet from the edge of the hub to the tip, and weighs complete 500 pounds. The circumference of the dial is approximately 120 feet, and the point of the minute hand travels 3 2/3 miles in seven days. For every minute the clock goes, the point of the minute hand covers 23 inches. The distance from center to center of the hour graduations is 10 feet, and the minute spaces or marks are 2 feet apart.

The clock, which was built by the Seth Thomas Clock Co., of Thomaston, Conn., is what is known as the Seth Thomas remontoir tower clock, and will require about 1,500 pounds of weights to propel the hands. It is claimed to be the most

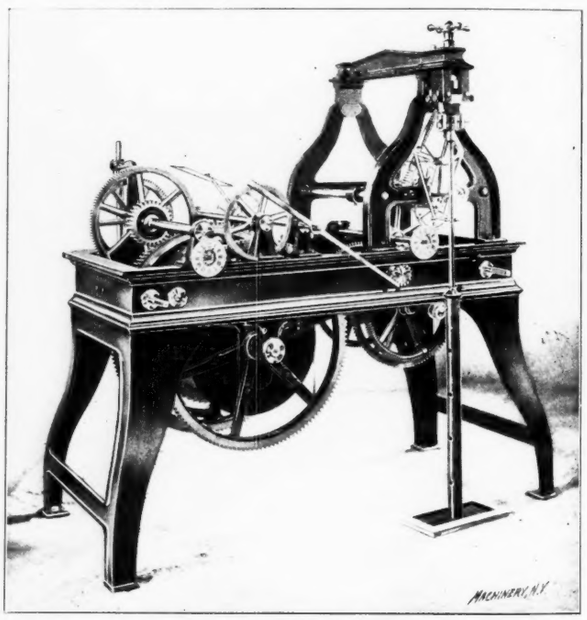


Fig. 3. The Seth Thomas Movement.

powerful as well as the most mechanically correct tower clock ever constructed. The pendulum rod, 8 feet in length, carries a cylindrical bob 330 pounds in weight. A refinement worth noting is that the bob is made with a rounding top to prevent dust from settling on it and affecting the accuracy of the time-keeper.

* * *

Count Zeppelin made a very successful trial of his airship in Switzerland, July 1, when the ship remained in the air for twelve hours, with Count Zepplin and a crew of fourteen men. He sailed over Lake Constance, making complicated evolutions, and over a large part of Northern Switzerland, visiting Zurich, Winterthur and Lucerne. It was claimed that no automobile was under more perfect control of the driver than the airship. It sailed with and against the wind, and throughout the voyage maintained an average speed of 34 miles per hour. The greatest altitude reached in the long voyage was 2,500 feet and the total distance covered was about 220 miles. This is the fourth large airship built by Zeppelin with a structural frame to hold the cigar-shaped body rigid. It is 435 feet long and 43 feet diameter.

Address: 621 Park Place, Brooklyn, N. Y.

LOCAL HARDENING AND TEMPERING.*

MANIPULATION OF TOOL STEEL BY THE FLEXIBLE COVER OR SHIELD METHOD.

WILLIAM A. PAINTER.†

William A. Painter.‡

In describing the shield process or method of local hardening and tempering of tool steel, I record some of the results of over four years of experimenting and practical application. The process is a radical departure from any practice in use at the present time so far as I know, and acts on a principle that appears not to have been recognized heretofore. We have demonstrated the wearing qualities of dies and tools so treated, by every-day use, and the efficiency of these as compared with tools treated by the conventional processes is decidedly superior. Breakage is reduced to a minimum, both in hardening and tempering and in use.

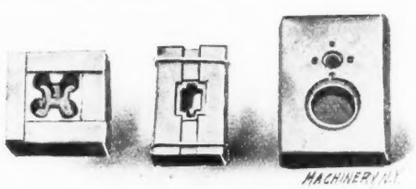
In using the shield method, the same judgment and common sense must be employed as in hardening by the regular method. If the hardener is hardening a piece that should be dipped in clear water, following the usual practice, it should be dipped in clear water when provided with the shield, and allowed to cool with the shield on. Or, if the piece is complicated and of delicate structure that requires cooling in oil, the same practice should be followed with the cover piece, dipping it in oil in the same manner. Again, if a special bath is required for certain work, use the bath in the same way for the shielded work. The results are exactly the same, except that with the shield method only the parts exposed harden, while the parts covered remain soft and in their natural condition.

A B C

Fig. 1. Blanking and Threading Dies in Protective Shield.

Heating.

For heating tool steel to be hardened by the shield method, the operator has the choice of any fire he prefers. An open forge answers the purpose for small work, but the furnace is better on account of the more even heat. A lead bath cannot be used because of the lead getting between the covers and the steel to be hardened, which will cause an explosion when dipped into water. This is not a serious drawback, as I do not consider that a lead bath has any marked advantages over a good coke or gas furnace. Moreover, the lead bath has a disadvantage in that it leaves a thin film or coating on the steel, which tends to keep the cooling bath from penetrating to the steel and cooling the piece as rapidly as it would cool if heated in a furnace.



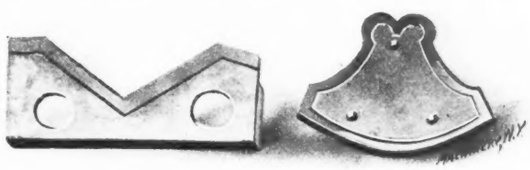
A B C

Fig. 2. Square Threading Die, and Press Dies with Covers ready for Hardening.

General Application of the Shield or Cover Method.

The shield method can be applied to almost all tool steel. Any brand or grade that is desirable to use can be handled in exactly the same way as without the shield. The advantage of the shield is that the essential wearing surfaces are hardened, and if these parts only require hardening, why harden the piece all over? A piece hardened all over is weakened by setting up internal strains and stresses which are likely to develop cracks and fractures and perhaps cause the ruination of an expensive part after it has been made all ready for use.

Gages of all kinds for external and internal use can be treated to advantage, and many gages now being made of machine steel and case-hardened can be made advantageously of tool steel in this manner, only the wearing parts being actually hardened, while the remainder is left soft. Multiple-throw crank-shafts for automobiles and high-duty automobile parts are readily treated by the shield method so that the actual wearing parts are hardened while the remainder of the piece is unchanged. Tool steel bearings for machinery may be hardened on the inside only, whether the bearing is in one piece or is split in two parts. Large rolls for rolling mills can be made with the journals soft or partly soft, thus avoiding the breakage of same at the shoulders. Hammer faces for pneumatic hammers can be treated at the shank so that the shank is soft while the die part is hard, thus avoiding the breakages now generally experienced. All kinds of drill jig bushings can be hardened, either externally or internally, as desired. Shear blades and other large pieces of similar use can be hardened on the cutting edges while the bulk of the metal is left soft.



A B

Fig. 3. Drop-hammer Die, and Punch with Shields.

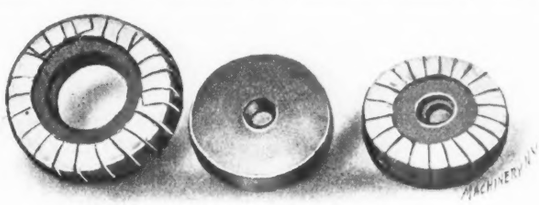


Fig. 4. Two Drawing Dies prepared for Local Hardening and One after Hardening.

Materials used for Shields.

In practice the thinnest possible cover to accomplish the desired results should be used. I have not had to use material thicker than 0.020 inch for ordinary work, and not thinner than 0.010 inch for small work. The thickness that serves best for average work is about 0.014 inch. The object of the shield is to cool the steel as quickly as possible under the cover without hardening same and without leaving a line of tension between the hardened and unhardened areas. The cover or shield can be made of any sheet iron or sheet steel, and scrap pieces, even if rusty, answer the purpose satisfactorily. Galvanized iron or tin plate should not be used, as the coating of zinc or tin when heated enters the steel and deteriorates it.

The shields or covers are made in different ways to suit the conditions. Some are made with top and bottom pieces with another strip or piece for the edge to act as a binder to hold the top and bottom in place and to protect the edges of the

* For previous articles on local hardening see "Tempering Hollow Mills and Other Tools," by J. P. Sallows, February, 1907, and "Pack-Hardening Gages," by E. R. Markham, June, 1908. The process here described was patented March 17, 1908. No. 882,162.

† Address: Pittsburg Lamp, Brass & Glass Co., Allegheny, Pa.

‡ William A. Painter was born in Waterbury, Conn. He was educated in the grammar schools of New York City and the College of the City of New York. He served an apprenticeship with the Matthews & Williard Mfg. Co., Waterbury, Conn., and has worked for the Miller Mfg. Co., Torrington, Conn.; Trenton Lamp Co., Trenton, N. J.; and is now master mechanic of the Pittsburg Lamp, Brass & Glass Co., Pittsburg, Pa. His specialty is manufacturing sheet metal goods and castings of all kinds.

piece. Some shields are made in one piece where the shape is not irregular. This applies in the case of round drawing dies and similar parts. In such cases, of course, the shield is formed to shape by cutting and bending. Where an irregular shape is to be cut out, the piece to be hardened is laid on the sheet metal and the outline scratched on same. The shape is cut out with a chisel, leaving a margin of the required width around the edges that are to be hardened. The width of this margin depends on the size of the part and the nature of the work. A pair of hand shears or snips, a small chisel, a scriber, hammer, punch and pliers are the principal tools necessary. A supply of sheet metal, rivets, and iron binding wire completes the outfit.

How the Shield Method Differs from Other Protective Methods.

Mechanical journals and books on shop practice have not treated of this method, although other methods very similar have been described. There are several methods moderately successful for local hardening and tempering, one being by dipping the piece part way into a bath, a practice that is commonly followed in hardening chipping chisels. Another method is holding a heated piece over and above the bath and directing a stream of water onto the part to be hardened. Large, round drawing dies having to be hardened on the inside are examples of this practice, a cone-shape spout being used at the bottom of the pipe to deflect the stream onto the interior of the die. A third method is that of making a box or form of heavy steel, cutting or drilling out the shape of the piece to be hardened. A lid is fitted to the box and the piece is heated in the fire, and after being heated is placed in the box and quenched. This method is objectionable in that the box, being made of thick material, causes uneven cooling, most of the heat having to be drawn off through the exposed parts of the piece. A fourth method is the use of fire-clay or asbestos wrapped around the parts to be left soft, the holes being plugged with fire-clay, asbestos or even putty. Iron wire is used to wrap around a non-conducting material to hold it in place. It then has to be baked in an oven or furnace until the moisture is dried out. Then the part is heated in the furnace to the hardening heat, and dipped. Inasmuch as these materials are poor conductors of heat and as the heat must be drawn quickly in order for the steel to contract evenly with the hardened or exposed parts, this method has not been very successful.

A B

Fig. 5. Reverse Drawing Die.

Fig. 6. Embossing Die.

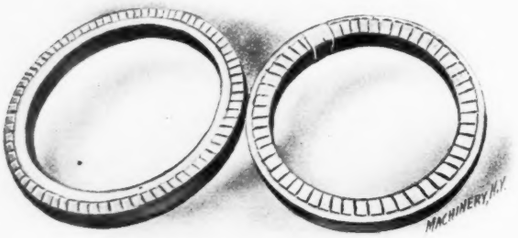


Fig. 7. Blanking Dies.

A piece of steel heated to a proper hardening heat and quenched in a box or shield of very thin steel or iron material, will remain soft because the water cannot cool it directly. Steam or vapor forms between the cover and the steel, driving the water away until the piece has cooled down. If holes are cut through the cover to let the steam out more rapidly, that part of the steel exposed will harden. To show that the steam imprisoned between the steel and the shield is a non-conductor of sufficient efficiency to make the difference between hardening and annealing, take a round piece of tool steel and fit a cover tightly around it, leaving half its length exposed. Heat this piece all over and cool all over. It will be found that the steel has hardened its full length under the cover, as well as on the exposed parts. The reason is that when the cover is tightly fitted no water can penetrate between the shield and the steel, and hence no steam is formed. The cover being thin, the steel cools rapidly and hardening takes place. This proves that the cover itself is a good conductor of heat, but the thin stratum of steam which will always exist between the cover and the piece as ordinarily fitted, is sufficient to check the hardening process.

A B C

Fig. 8. Samples of Lathe Tools with Shields.

Description of Work Locally Hardened.

The part shown in Fig. 1 at *A* is an ordinary blanking or cutting die and is an example showing how any shape to be hardened can be outlined in the cover. The cover is made in two pieces, the top and sides being one piece and the bottom the other piece. The material of this shield is No. 26 sheet steel and is about 0.018 inch thick.

The second piece shown in Fig. 1 at *B* is a round threading die, and the shield is applied so that the threads only are hardened, the exterior remaining soft. It illustrates a very practical use of the shield method. The die is split at one point, being of the adjustable type. Inasmuch as only the teeth are hardened, there is no danger of cracking the die in adjustment, and there is less distortion and change of pitch. The cover is made in one piece and can be used several times before being destroyed by the heat.

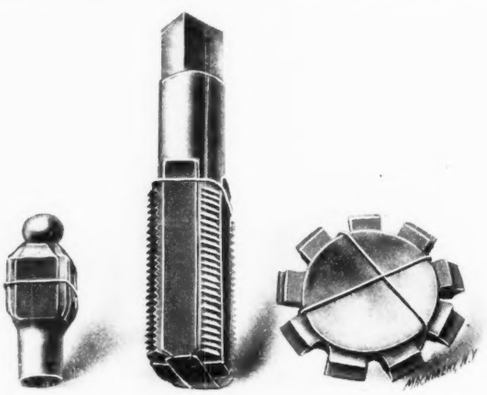


Fig. 9. Miscellaneous Examples.

The third piece shown in Fig. 1 at *C* is a plain blanking die, but instead of being hardened around the edge of the cutting part as in *A*, it is hardened half the thickness of the steel, leaving the whole lower half soft, this being protected by the cover, while the upper half is hardened. This gives the die all the advantages of a die made of composite steel, a material that is made of half tool steel and half soft steel or iron welded together. This material is extensively used on small die work, but the shield method makes its use unnecessary as all its advantages are obtained very simply, and it never splits at the weld as is sometimes the case with composite steel.

A square threading die is shown in the shield at *A* in Fig. 2, and the same remarks apply in regard to distortion and change of pitch as in the case of the round threading die. At *B* is shown a press die in its cover ready to be hardened. The exposed portion is not large in proportion to the size of

the die, but it will harden just as well as if there were a half inch margin exposed all around the edge. The cover is held on by iron wire. Brass wire or rivets should not be used, as the heat destroys them. At *C* is shown a progressive or following die. There is nothing of special interest in the design, but the method of hardening a narrow ring around each hole is unique. The cover is cut out so as to leave a narrow margin of exposed steel around each hole. The die is hardened exactly as the cover shows, the remainder of the body being soft, as before dipping.

In Fig. 3 at *A*, is a forming die for drop-hammer. It is 8½ inches long, ¾ inch thick and 4 inches high, and has been

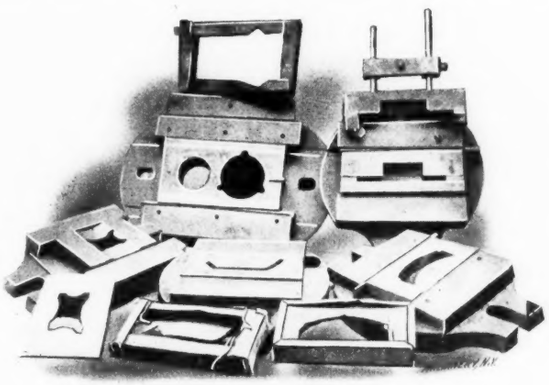


Fig 10. Group of Large Dies and Covers.

hardened all around the outline of the top or face for a width of ½ inch. The scale is still on the steel and no finishing has been done. The cover had two large holes cut out to balance the cooling as the narrow center would warp the bottom. This piece was hardened without warping. At *B* is shown a large blanking punch with the face up. In hardening large punches it is only necessary to harden an area around the cutting edge. The steel plate or cover on the face of the punch is 0.020 inch thick and was held to the face of the punch by three 3/16 inch screws, holes being drilled in the face of the punch to correspond. This is a good example of cover hardening and demonstrates its value, as the punch retains its shape perfectly after being dipped.

Two drawing dies are shown in Fig. 4 with the covers on ready to harden, and a third die is shown without a shield. These shields are made in one piece and can be used over

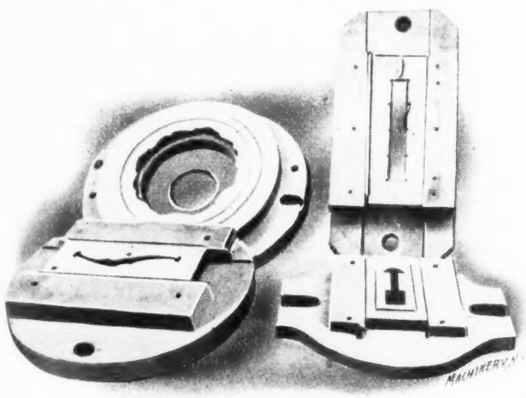


Fig. 11. Another Group of Large Dies.

again. A drawing die needs to be made as hard as possible, and yet when a die is hardened all over it is necessary to draw the temper in order to relieve the internal strains. By the shield method the working part is made as hard as it can be made while the soft part gives it a suitable backing and strength. The shrinkage can be regulated by the thickness of the shield or by putting vent holes around the edge of same. The vent holes let out the steam and cause the shielded part to cool more rapidly. Dies hardened by the shield process can be shrunk repeatedly to take up the wear.

A reverse drawing die 6 inches outside diameter, 5 inches inside diameter, with hardened ring riveted to the top or wearing edge, is shown in Fig. 5 at *A*. At *B* is illustrated the method of hardening the ring, leaving the shoulder or bottom edge soft by covering it with a shield of thin steel. The ring can be fitted after hardening, driven on a shoe and holes drilled through from outside of the machine steel shoe, and riveted. The hardened portion is then ground to size. If the top ring were welded to the shoe it would have to be discarded when worn down.

In Fig. 6 is shown an embossing die made of tool steel. It is 8½ inches diameter and 3 inches thick. This die was covered on the bottom and sides with No. 25 sheet steel 0.020 inch thick and placed in a basket or hanger so that it could be immersed by a tackle. The embossed part was filled with bone dust for protecting it in the fire, but charcoal or any suitable filling will do as well. When covering shallow dies, the top edge should be left standing about a half inch above the face of the die instead of being folded over, as shown in the illustration. This face is filled in as described above as the filling will protect the face of the die. It should be left in, when dipped, and the die should be suspended face up and about 3 inches below the water level, while a stream of water of large volume but low pressure is directed against the center of the die while the die is moved around in the tank. This can be done with one hand holding the tackle while the other hand directs the stream. The filling or packing will float away, leaving the surface of the die clean. A ¾-inch hose without nozzle is about right for ordinary work.

In this connection it may be mentioned that a skeleton platform with hanger is an advantage for handling large work, as any piece too large for tongs can be placed on the platform and lowered into the tank. It may be cooled from the

Fig. 12. Miscellaneous Collection of Shields or Covers showing Range of Application.

bottom, if necessary, as well as from the top. Some shapes give better results if covered only on the sides, leaving the top and bottom exposed. The hanger gives the bottom a chance to cool off, but not as rapidly as the top where the stream of water is directed. This method is an improvement over the present way of hardening drop forging dies, this class of hardening being regarded as very difficult where the shapes are irregular and the thickness of the walls uneven. It will apply to all deep or hollow dies.

To the left in Fig. 7 is shown a blanking die 11⅛ inches inside diameter, 1¼ inch thick and 1¼ inch width of walls. This die is covered and hardened in the regular way. The temper is drawn, after which it can be placed in the lathe and trued up. The outside is as soft as it was before dipping. Obviously, this die is much stronger than one hardened all over. At the right is shown a blanking punch 11⅛ inches outside diameter, 1⅛ inch thick, with walls 1⅛ inch wide. It is hardened on the outside only and the temper is drawn. The inside is as soft as before hardening, and is made a driving fit on a cast iron holder. The fit can be made a very tight drive without danger of cracking the ring.

Fig. 8 shows the application of the shield method to hardening lathe tools. At *A* is shown a right-hand side tool of carbon steel hardened on the cutting face only, the back being left soft. The cutting edge can be left much harder than usual without danger of weakening the tool. At *B* is shown a self-hardening tool that has been heated up to the proper temperature without cover and the cover applied to the tool before dipping in oil. This method works equally as well on air-hardened tools, the cover being put on before holding the tool in the air-blast. The breakage of self-hardening steel tools is an expensive item and usually amounts to

more than the actual wear of the tools, but if they are made with a soft back or partly soft back and with only the working parts hard, as will be the case with the shield process, the tool is much stronger, and is much less liable to fracture in service. At *C* is a half diamond point lathe tool which is hardened only on the working face. The sheet covers can be applied to any shape of lathe or planer tool by any one of ordinary mechanical skill.

In Fig. 9 a ball peen hammer is shown placed ready for hardening and the eye for the handle is not filled, but is covered with a shield of steel wrapped around the part to be kept soft. The eye will not harden, as the heat of the steel inside of the cover, when dipped, creates steam which drives the water back until the heat is reduced. The milling cutter in this illustration is shielded with two circular plates 0.020 inch thick and the hole in the center is not filled. The disks of sheet metal are held together by iron wire, and any desired area on the sides of the cover can be left soft by making the size of the disks to suit. This is far better than the heavy plates that are generally used, as the heat is drawn off more rapidly, leaving less internal stresses in the steel. The tap shown has been hardened on the teeth only, the body and shank being shielded so that they are left soft. Taps hardened in this manner are truer in the pitch and the size is less likely to be changed than if hardened all over. The preparation of the cover took less than 5 minutes' time,

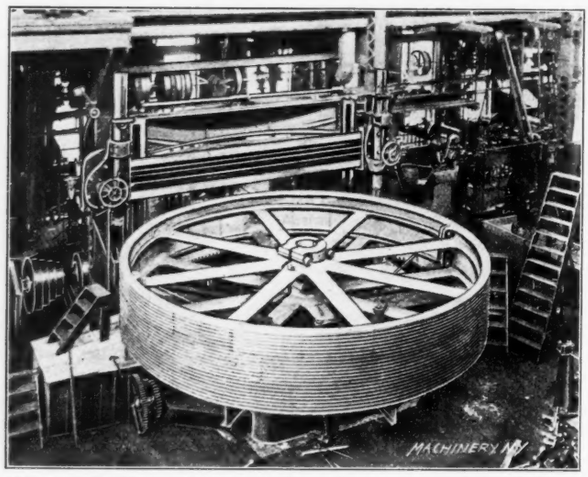


Fig. 1. Rope Sheave 20 Feet in Diameter for Driving Refrigerating Plant.

only two strips of sheet steel being required and a short section of iron binding wire. Flat drills are hardened on the point and sides only, the center being left soft. Such drills will not snap off short when caught in the work, but will bend before breaking. The shield consists simply of two thin plates held on by iron wire.

Fig. 10 illustrates a group of large dies and their covers. In Fig. 11 is illustrated another group of large dies, and in Fig. 12 is shown a miscellaneous collection of covers that have been used to shield work from ¼ inch diameter to 12 inches diameter. The shields are made mostly from stock 0.010 to 0.020 inch thick. Some of the circular shields have been in the fire several times.

My conclusion is that the shield method of local hardening is applicable to a vast range of work, and that the cutting tools, dies, taps, gages, etc., locally hardened and tempered, are less likely to warp and change in shape in hardening and are more durable in service than when hardened in the common way. The application of the shields is cheap, and any one of ordinary skill is able to cut them out and apply them to the work. The saving in breakage alone will more than pay the expense of applying the shields, while the greater durability of tools so hardened makes the process profitable to follow.

* * *

One of the most remarkable flying machine performances, undertaken under the auspices of official supervision, is that of Delegrange, a French aeronaut, who, on June 22, with an aeroplane covered a little more than 11 miles in 16½ minutes, making nine rounds of a measured course.

LARGE ROPE SHEAVE—CUT GEARS OF UNUSUAL DIMENSIONS.

A rope sheave 20 feet in diameter, with 20 grooves for 2-inch rope, weighing 48,000 pounds finished, was recently made by H. W. Caldwell & Son Co., Chicago, Ill. The sheave is shown in Fig. 1 on the boring mill. It has a double set of arms, and was cast in one piece and then split apart for convenience in handling and erecting. It was cast in the

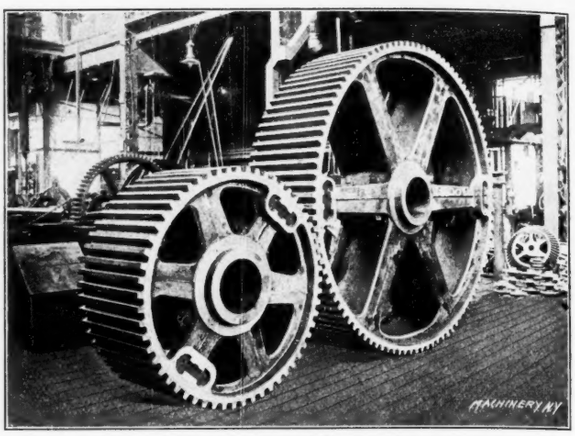


Fig. 2. Heavy Cut Gears of Unusual Dimensions.

foundry of the company, and was finished on a 20-foot boring mill. The sheave will be used in connection with the main drive of a refrigerating plant in Mexico to reduce the speed of an electric motor, the motor being direct connected to a small sheave. The transmission is by means of what is generally known as the American or single rope system.

Figs. 2 and 3 show a pair of heavy cut gears of unusual dimensions, recently produced in the same works. The gears are of semi-steel mixture, and were cast in halves and the joints planed. The weight of the large gear is 13,800 pounds and of the small gear 8,000 pounds. The diameter of the large gear is 95.51 inches, 100 teeth, and of the small gear 55.41 inches, 58 teeth. The width of the face is 27 inches and the pitch is 3 inches. The teeth were machined in a Gleason gear planer, it being preferable to plane the teeth rather than mill them on account of the extraordinary dimensions of the gears. It may be said as a general proposition that it is preferable to plane spur gears in all sizes above 2 or 2½ cir-

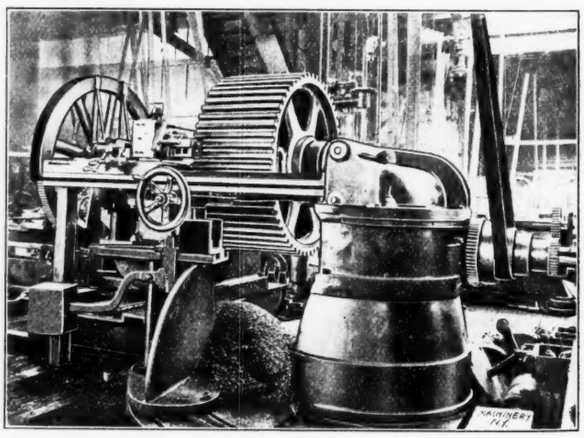


Fig. 3. Gears being planed on a Gleason Gear Planer.

cular pitch. The gears illustrated are to be used in connection with the drive of a mining hoist in the Lake Superior copper mines.

* * *

The Pennsylvania Railroad has had a long line of engineers for presidents, and for many years it did not list its stock on the New York Stock Exchange. The pre-eminence of this corporation over all other railway organizations as a legitimate enterprise is undoubtedly due to these facts and to the sense of duty and practical ability of its presidents.—*W. D. Marks, in Engineering News.*

JIGS AND FIXTURES—5.

EINAR MORIN.*

CLAMPING DEVICES (Continued.)

It was mentioned in the previous installment, appearing in MACHINERY last month, that the loose leaf construction, as a rule, is only used when a guide bushing can be put into the leaf, because its construction is rather expensive to use for the single purpose of clamping. When the leaf is simply intended to hold one or more set-screws by which the work is held down, it may be made and fastened as shown in Fig. 51. In this case, the name "leaf" is rather out of place, and this fastening device becomes merely a strap. Some improvements of this kind of clamping device are shown in Fig. 52, where the ends of the strap are slotted in various ways so as to permit getting the strap out of the way rapidly when the work is to be removed.

The ordinary jack-screw is used to some extent as a clamping device in drill jigs, but the objection to its use is that, not being an integral part of the jig, it is very apt to get lost. In Fig. 53 are shown two simple devices working on the same principle as the jack-screw, but having the advantage of being connected to the jig by the pin shown at *B*. At *A*, in Fig. 53, a set-screw screws directly into the end of the eye-bolt, and at *C* a long square nut is threaded on the eye-bolt. These nuts must be made of special length, and be made up especially for this purpose. The eye-bolts are fastened, as

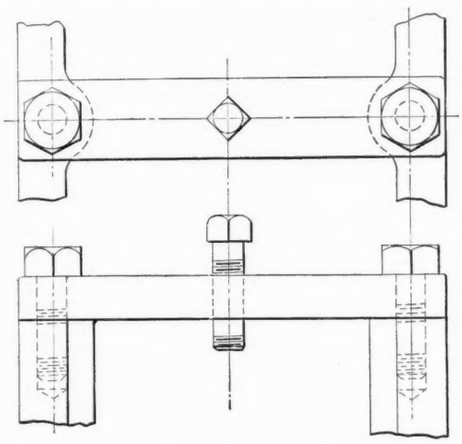


Fig. 51. Common Clamping Strap.

shown, directly to the wall of the jig, and the set-screw or nut is tightened up against the work. The eye-bolt can be set at different angles to suit the work, thereby providing a clamping device which may be said to possess double adjustment. This device makes a very convenient clamping arrangement. It works satisfactorily, and has the advantage of being easily swung out of the way.

The principles of clamping work in the jig by means of a wedge or tapered gib is illustrated in Fig. 54. The work is located between the wedge *A* and the wall *B* of the jig and pressed up against the wall by the wedge which can be driven in by a hammer, or screwed in place when the jig is constructed as shown. It is preferable to have the wedge screwed in place, as it is then less apt to loosen by the constant vibrations to which it is subjected, and at the same time the wedge is less apt to get lost, being an integral part of the jig. The ear for the screw may be placed in any direction in regard to the gib, as indicated by the dotted lines in the end view of Fig. 54. This tightening device is, in particular, adapted to work of dove-tail shape, as shown in Fig. 55. In this case the wedge is made similar to the common taper gib used for taking up the wear in dove-tail slides. It is sometimes of advantage to relieve the bearing surface opposite the wedge, as shown in dotted lines in Fig. 54, in order to provide two distinct bearing points, which prevents the work from rocking.

If it is required to get a bearing on two points of a surface that is likely to vary in its dimensions, a yoke can be used, designed on the principle of that shown in Fig. 56. In the engraving, *A* is the work to be clamped, and *B* is the yoke which fits into a slot in the center of the strap or clamp *C*. The yoke is held by a pin *D*, around which it can swivel to adjust itself to the work. It is evident that the amount of pressure at the two points *E* and *F* will be equal, or at least near enough for all practical purposes, even though the screws at the ends of the strap may not be equally tightened. In

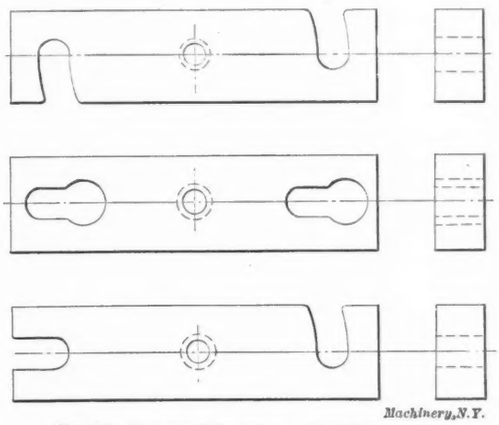


Fig. 52. Improved Designs of Clamping Straps.

this device the pin *D* takes the full clamping strain, and should therefore be designed strong enough, and the strap which is weakened by the slot and the hole in the center, should be reinforced, as indicated, at this place. It is preferable to have spiral springs at each end of the strap to prevent the strap from slipping down when the work is taken out. The strap may be made either of cast iron or machine steel, the yoke being made out of machine steel.

Eccentric clamps and shafts for binding purposes are often used. In Figs. 57 and 58 are shown two applications of the principle of the eccentric shaft. In Fig. 57 the eccentric shaft *A* has a bearing at both ends, and the eye-bolt *B* is connected to it at the center and is forced down when the eccentric shaft is turned. This causes the two end points of the clamp *C* to bear on the work. This clamping arrangement has a very rapid action and gives good satisfaction. The throw of the eccentric shaft may vary from 1/16 inch to about ¼ inch, depending upon the diameter of the shaft and the accuracy of the work. In cases where it is required that the clamp should bear in the center, an arrangement like the one shown in Fig. 58 may be used. Here the eccentric shaft *A*

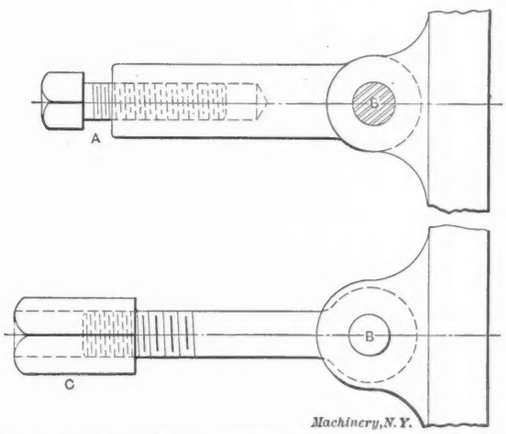


Fig. 53. Clamping Devices working on the Jack-screw Principle.

has a bearing in the center and eye-bolts *B* are connected to it at the ends. As the eccentricity is the same at both ends, the eye-bolts or connecting-rods will be pulled down evenly when the lever *C* is turned, and the strap *D* will get an even bearing on the work in the center. If the force of the clamping stress is required to be distributed equally at different points on the work, a yoke like that shown in Fig. 56 may be used in combination with the eccentric clamping device in Fig. 58.

*Address: 833 W. Sixth St., Plainfield, N. J.

When it is essential that the strap *D* should also be used for locating purposes, necessary guides will be provided for the strap, so as to hold it in the required position. These guiding arrangements may consist of rigid rods, ground and fitted into drilled and reamed holes in the strap, or square bars held firmly in the jig, and fitted into square slots at the ends of the strap. The bars can also be round, and the slots at the ends of the strap half round, the principle in all cases remaining the same, excepting, of course, that the more rigid the guiding arrangement is, the more may the accuracy of the locating be depended upon.

The ordinary eccentric lever works on the same principle as the eccentric rods just described. There is a great variety of eccentric clamping devices, but they are not as commonly used in present-day jig design as they used to be a few years ago. The eccentric clamping levers, however, provide good and rapid clamping action. In Fig. 59 is shown one especially intended for clamping finished work. It is not advisable to use this kind of lever on rough castings for the reason that these latter may vary so much that the cam or eccentric will have to have too great a throw for rigid clamping to suit the rough castings. The extreme throw of the eccentric lever

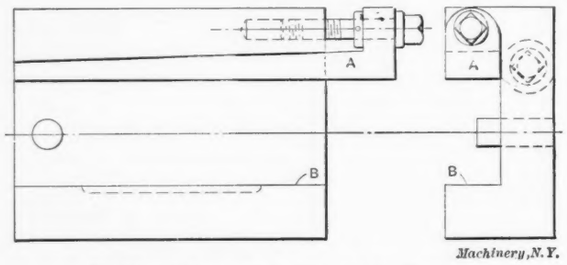


Fig. 54. Wedge or Taper Gib used for Clamping.

should in general not exceed 1/6 of the length of the radius of the eccentric arc if the rise takes place during one-quarter of a complete turn of the lever. This would give an extreme throw of say ¼ inch for a lever having 1½ inch radius of the cam or eccentric. Even to one unfamiliar with this kind of work it is plain that as the eccentric cam swivels about the center *A*, the lever being connected to the jig with a stud or pin, the face *B* of the cam, which is struck with the radius *R* from the center *C*, recedes or approaches the side of the work, thereby releasing it from, or clamping it against, the bottom or wall of the jig. The lever for the eccentric may be placed in any direction, as indicated by the full and dotted lines in Fig. 59. In Fig. 60 is shown another eccentric lever, which is used frequently on small work for holding down straps or leaves, or for pulling together two sliding pieces, or one sliding and one stationary part, which in their turn hold the work. These sliding pieces may be V-blocks or some kind

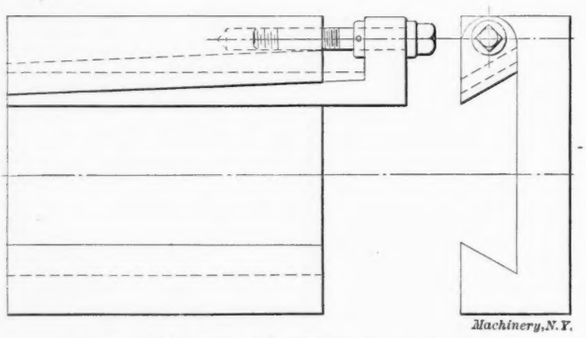


Fig. 55. Wedge used for Clamping Dove-tailed Work.

of jaws. The cam lever is attached to the jig body, the leaf, or the jaw, by a pin through hole *A*. The hook *B* engages the stud or pin *C* which is fastened in the opposite jaw or part, which is to be clamped to the part into which the pin through hole *A* is fastened.

The variety of design of eccentric cam levers is so great that it is impossible to show more than the principles, but the examples shown embody the underlying action of all the different designs.

The Design of Jigs.

To give any rational rules or methods for the design of drill jigs would be almost impossible, as almost every jig has to be designed in a somewhat different way from every other jig, to suit and conform with the requirements of the work. All that can be done is to lay down the principles. The main principles for jigs as well as fixtures were treated at length

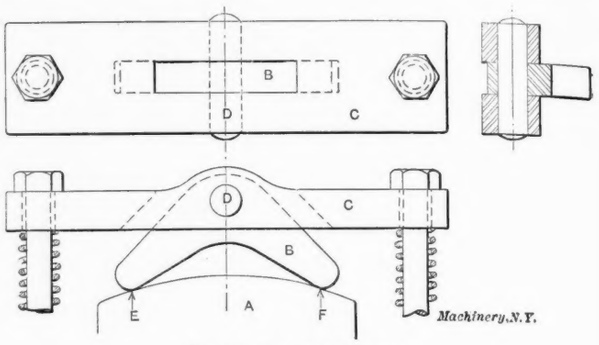


Fig. 56. Equalizing Clamp.

in the first installment (April issue) of these articles. It is proposed in the following to dwell more in detail on the carrying out of the actual work of designing jigs.

Before making any attempt to put the lay-out of the jig on paper, the designer should carefully consider what the jig will be required to do, the limits of accuracy, etc., and to form, in his imagination, a certain idea of the kind of a jig that would be suitable for the purpose. In doing so, if a model or sample of the work to be made is at hand, it will be found to be a great help to study the actual model. If the drawing, as is most often the case, is the only thing that is at hand, then the outline of the work should be drawn in red

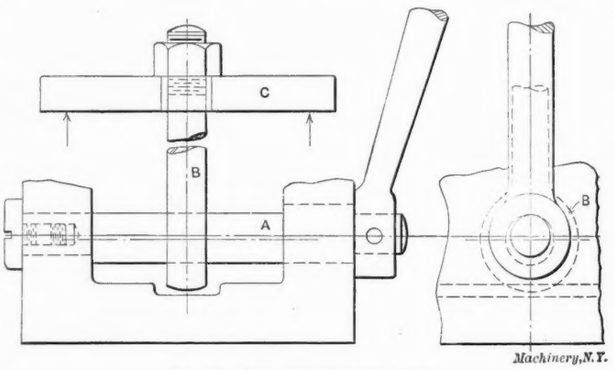


Fig. 57. Eccentric Clamping Bolt.

ink on the drawing paper, on which the jig is subsequently to be laid out, and the jig built up, so to speak, around this outline. The design of the jig will be greatly simplified by doing this, as the relation between the work and the jig will always be plainly before the eyes of the designer, and it will be more easily decided where the locating points and clamping arrangements may be properly placed. When drawing and projecting the different views of the jig on the paper, the red outline of the work will not in any way interfere, and when the jig is made from the drawing, the red lines are simply ignored, excepting to the extent in which the outline of the pieces may help the toolmaker to understand the drawing and the purpose of certain locating points and clamping devices.

If it is possible, the jig should be drawn full size, as it is a great deal easier to get the correct proportions, when so doing. Of course, in many cases, it will be impossible to make the jigs full size. In such cases the only thing to do is to make them to the largest possible regular scale. Every jig draftsman should be supplied with a set of blue-prints containing dimensions of standard screws, bolts, nuts, thumbscrews, washers, wing nuts, sliding points, drills, counterbores, reamers, bushings, etc.; in short, with blue-prints giving dimensions of all parts that are used in the construction of jigs, and which are, or can be, standardized. It should be

required of every designer and draftsman that he use these standards to the largest possible extent, so as to bring down the cost of jigs to as low a figure as possible.

If it does not meet with objections from higher authorities, which it ought not to, it is highly advantageous for the obtaining of best results, that, before starting on the drawing, the draftsman who is to lay out the jig should converse with the foreman who is actually going to use the jig. Oftentimes this man will be able to supply the best idea for the making of the jig or tool. Not only is advantage taken of the combined

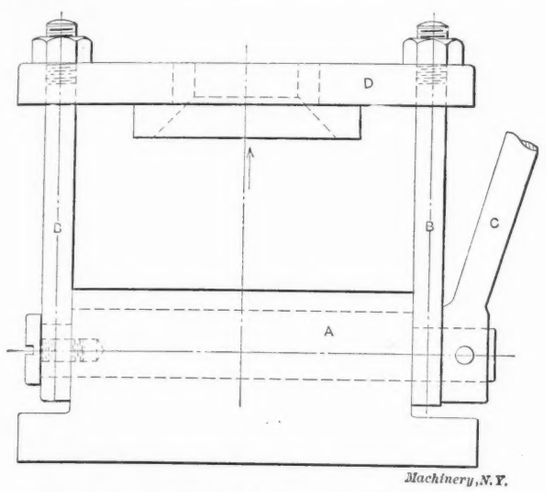
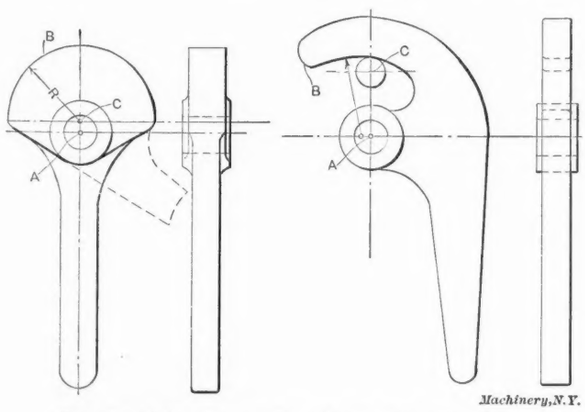


Fig. 58. Another Example of Eccentric Clamping Bolt.

experience of the draftsman and the foreman, but it is also a precaution of great importance for making all parties feel satisfied.

As a jig drawing, in most cases, is only used once, or at most only a very few times, it is not considered worth while to make a tracing or blue-print from the drawing, but, as a rule, the pencil drawing itself may be used to advantage. If, however, it is given out in the shop directly as it comes from the drawing-board, it is likely to get soiled, and to be used in such a manner that, after a while, it would be impossible to make out the meaning of the views shown on it. For this reason, in the first place, jig drawings should be made on some heavy paper, preferably of brown color, which is not as quickly soiled as white paper. In order to prevent the drawing being torn, it should be mounted on strawboard, and held down along the edges by thin wooden strips, nailed to



Figs. 59 and 60. Cams or Eccentrics used for Clamping.

the board. It is also desirable to cover the drawings with a thin coat of shellac before they are sent out in the shop. When this is done, the dirt and black spots which will always be found on the drawing when it stays in the shop, even if but for a few hours, may be washed off directly; and the shellac itself may be washed off by wood alcohol, when the drawing is returned to the drafting-room. The drawing, after having been cleaned, is then detached from the strawboard, which latter may be used over and over again. The drawing is, of course, filed away, according to the drafting-room system.

The most advantageous sizes for jig drawings for medium to heavy work are as follows:

Full size sheet, $40 \times 27\frac{1}{2}$ inches.
Half size sheet, $27\frac{1}{2} \times 20$ inches.
Quarter size sheet, $20 \times 13\frac{3}{4}$ inches.
Eighth size sheet, $13\frac{3}{4} \times 10$ inches.

Of course, these sizes will vary in various shops, and in many cases, particularly when the tool designing department and the regular drafting-room are combined as one drafting department, the jig drawings should be of the same regular sizes as the ordinary machine drawings.

It is common in a great many shops to make no detailed drawings of jigs, but simply to draw a sufficient number of different views and sections, and to dimension the different parts directly on the assembly drawing. In cases where the jig drawings are extremely complicated, and where they are covered with a large number of dimensions which make it hard to read the drawing and to see the outlines of the jig body itself, it has proved a great help to trace the outlines of the jig body, and of such portions as are made of cast iron, on tracing paper, omitting all loose parts, and simply putting on the necessary dimensions for making the patterns. A blue-print is then made from this paper tracing, and this is sent to the pattern-maker, who will find the drawing less of a puzzle, and who will need to spend far less time on making out how the pattern actually looks. A less skilled, and consequently a cheaper, man may also be used for making the pattern. It is, however, greatly to be doubted whether it is good policy not to detail jig drawings completely, the same as other machine details.

When jigs are made up for pieces of work which require a great many operations to be carried out with the same jig, and where a great number of different bushings, different sizes of drills, reamers, counterbores, etc., are used, a special operation sheet should be provided which should be delivered to the man using the jig, together with the jig itself. This enables him to use the jig to best advantage. On this sheet should be marked the order in which the various operations are to be performed, and the tools and bushings which are to be used. Of course, the bushings in such a case should be numbered or marked in some way so as to facilitate the selection of the correct bushing for the particular tool with which it is used. If this system is put in force and used for simpler classes of jigs also, the operator will need few or no instructions from his foreman, outside of this operation sheet.

* * *

A summary of the available water powers of the world has been published by the *Revue Electrique*. It is stated that in the United States there is 1,500,000 horse-power possible of utilization. Among the European countries, France has an estimated available water power of 4,500,000 H. P., of which 800,000 H. P. is utilized. The region of the Alps extending into France brings the figure as high as mentioned. Italy, it is stated, has an equal amount of water power available, but only 300,000 H. P. is utilized as yet. In that country, falls of 10,000 H. P. are abundant. The estimate for the available water power in Switzerland is incomplete, but 300,000 H. P. is in use. The available power in Germany is 700,000 H. P., 100,000 H. P. being utilized. In Norway the estimated power is 900,000 H. P., and in Sweden 760,000, a large part of which is already developed in both countries. As regards available water power, Russia heads the list, it being estimated that 11,000 000 H. P. could be taken out of the Russian rivers, of which only 85,000 H. P. has been developed. Great Britain and Spain come last in the estimate, only 70,000 H. P. being utilized in either country. It is stated that Japan has available water power of 1,000,000 H. P., of which only 7 per cent has as yet been utilized. The estimate for the water power in the United States is without question considerably below the actual figures. It has been stated, on good authority, that there is already developed, or under development, in the United States, 4,500,000 H. P. from water sources, and the government's statistical figures indicate that the available water power in the country is nearly 10,000,000 H. P. In New England alone there is 1,000,000 H. P. developed, with probably another half million available.

CUTTING LONG LEAD-SCREWS ON THE THREAD MILLING MACHINE.

There is, perhaps, no work on which the convenience and economy of using the thread milling machine has been better exhibited than when cutting long lead-screws, which, if the thread should have been produced in an ordinary lathe, of about the same capacity as the thread milling machine, would have caused a great deal of trouble in order to obtain proper supports while cutting the thread. The accompanying half-tones, Figs. 1 and 2, show two long lead-screws being cut in thread milling machines. These lead-screws are used on the gun-barrel drilling machines built by the Pratt & Whitney Co., Hartford, Conn., and the photographs were taken when the lead-screws were being cut in thread milling machines in the company's shop.

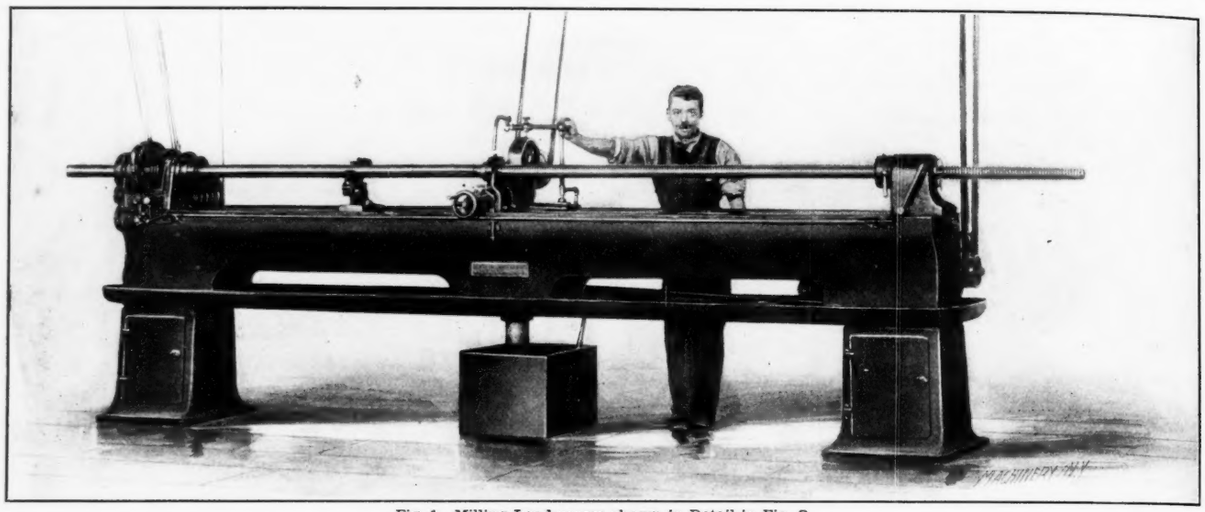


Fig. 1. Milling Lead-screw shown in Detail in Fig. 3.

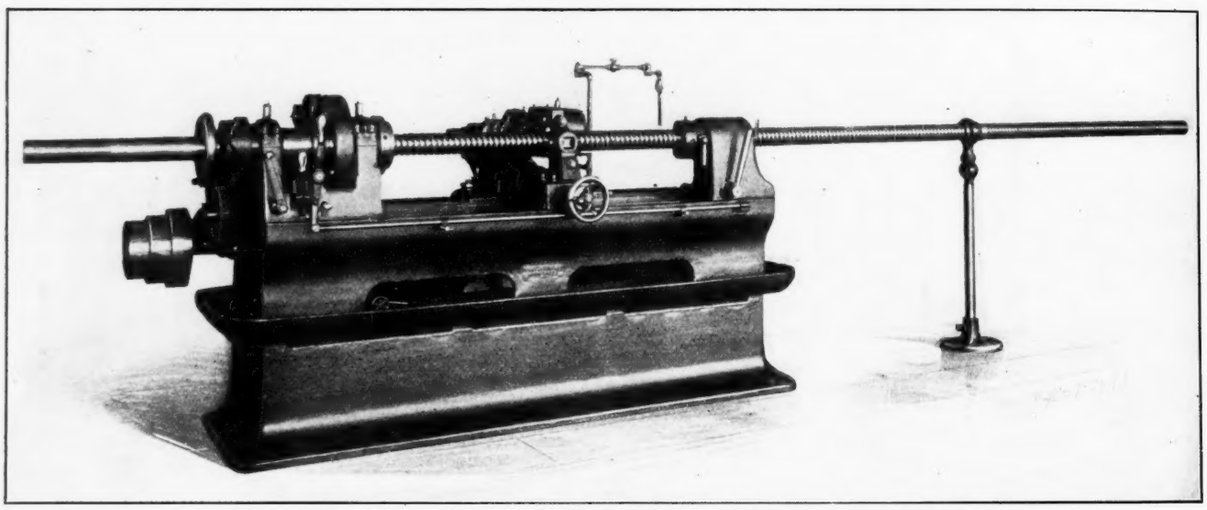


Fig. 2. Lead-screw shown in Detail in Fig. 4, cut in a Pratt & Whitney Thread Milling Machine.

The lead-screw shown being cut in Fig. 1 is shown in detail in the engraving, Fig. 3. It was not possible to include in the photograph the full length of the screw, as it extended a considerable distance from the left side of the machine. The length of the threaded portion of this lead-screw is 34 feet 8 inches, and the diameter of the thread is 2½ inches, there being 3 Acme threads per inch. The thread

The lead-screw shown being cut in Fig. 1 is shown in detail company's 6 x 80-inch thread milling machines, and, on account of the length of the screw, it was required to move or shift the carriage back five times to complete the screw, so that the carriage traversed the full length of the machine six times in all before having completed the screw. The cutter, of course, milled the thread to its full depth and shape in one cut, no finishing cut or second operation whatever being required. The surface speed of the cutter, while cutting, was about 96 feet per minute, and the surface feed of the work 3.9 inches per minute, 42 hours being required to complete the cutting of the whole lead-screw.

The lead-screw shown in detail in Fig. 4 was cut on one of the company's thread milling machines, as shown in Fig. 2. This machine is of a far heavier construction than the one shown in Fig. 1, and is known as a 12 × 48-inch thread milling machine. As this machine does not permit as long travel of the carriage, on account of the bed being so much shorter, it was necessary to shift the carriage eight times, or to traverse the length of the bed nine times in all, in order to cut the full length of the thread, which, in this case, was 34 feet, 8⅞ inches. This screw had but one Acme thread per inch, right-hand, single, the diameter of the lead-screw being 3½ inches. The surface feed was 2½ inches per minute, and the surface speed of the cutter was about 66 feet per minute.

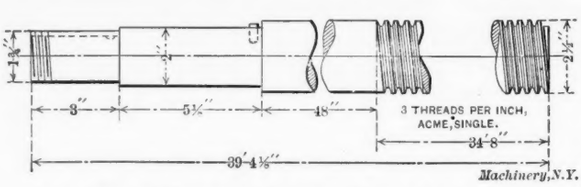


Fig. 3. Detail of Lead-screw for Pratt & Whitney No. 3 Gun-barrel Drilling Machine.

With the feed stated the actual cutting time was about 30½ hours, but it would have been possible to cut with a heavier feed, at least 3 inches, in which case the time required would only have been 25½ hours. The thread of this lead-screw, the same as the thread of the lead-screw previously referred to, was finished with a single cut, and it was considered that

the thread was fully as smooth and more perfect to shape than would have been the case if the thread had been cut with the greatest of care in an ordinary lathe.

We have no records on hand which intimate how long it would take to finish a screw on an ordinary lathe, with an equal degree of accuracy, but such comparative figures would be highly interesting. The thread miller requires less attendance, and outside of the operator's time gained, the convenience in doing the work, passing the bar right through

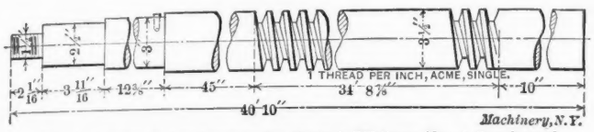


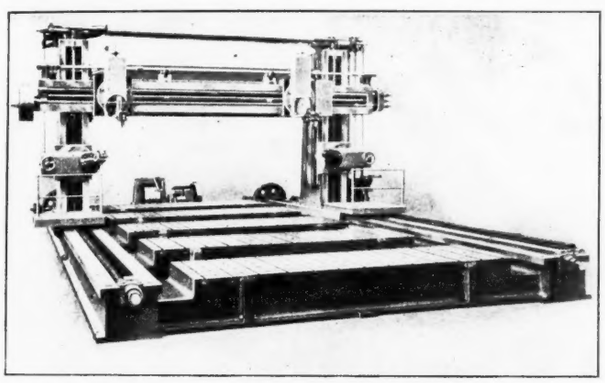
Fig. 4. Detail of Lead-screw for Pratt & Whitney No. 4 Gun-barrel Drilling Machine.

the spindle and foot-stock, and simply supplying standards for the support of the overhanging ends of the screw, is apparent to anybody who has seen or had experience with the difficulties attending the cutting of long lead-screws in ordinary lathes, where, for instance, sometimes portion after portion of the length of the screw has to be welded onto the previously completed part, in order to enable the length of the lathe bed to accommodate the excessive length of the lead-screw being cut.

* * *

A LARGE PLANER OF ENGLISH DESIGN.

The accompanying half-tone engraving illustrates an exceptionally large planer of a type built by Messrs. Joshua Buckton & Co., Ltd., of Leeds, England, which was described and illustrated in a recent issue of *Engineering*. This planer is intended, in particular, for planing the casings for large steam turbines, and for other work of a very heavy nature



A Large English Planer which takes Work 20 Feet Wide, 10 Feet High, and 30 Feet Long.

occurring in steam engine design. The particular feature of the machine, it will be noticed from the illustration, is that the standards or housings travel, while the bed proper is stationary. The machine is of exceptionally large dimensions, it having a capacity for planing work 20 feet wide, 10 feet high, and 30 feet long. The table of the machine is built in sections, separated by large gaps. On each side of the table are longitudinal flat ways on which the standards travel. These latter are driven by two screws of steep pitch, one for each housing. The screw in turn receives motion through a bevel gear connection with a cross-shaft at the back end of the bed. The sliding ways are furnished with roller lubricators, and the thrust of the screws is taken by ball bearings. In the machine illustrated the cross-slide is adjustable vertically, the same as in an ordinary type of planer, but another type is made by the same firm with fixed cross-slide, the work being placed in a pit in the center of the machine. The tool heads are fitted with double-cutting tool-holders, carrying two self-relieving tools for cutting on both the forward and the backward strokes of the machine. One of the heads on the cross-slide can be arranged for traverse planing, the tool traversing to and fro on the slide for this purpose, and cutting in both directions. The drive for this motion is obtained from a separate electric motor, mounted on the back of the cross-slide. When work is being planed in this manner, the feed is given to the cutting tools by a slow automatic travel of the standards on the ways along the bed. A headstock for drilling and milling is also provided which fits on the cross-slide. It is of interest to compare this planer with the one illustrated in the January, 1908, issue of MACHINERY, built by the Bement-Miles Works at Philadelphia. In this planer the distance between the uprights was 14 feet 4 inches, the maximum distance from the table to the bottom of the cross rail, 12 feet 2 inches, and the maximum stroke of the table 30 feet. In this planer the table moved while the housings were stationary, the same as in ordinary planers.

* * *

LARGE HORIZONTAL BORING AND TURNING MILL.

The accompanying two half-tone engravings illustrate what is undoubtedly the largest boring mill ever built. This machine was completed some time ago in the works of the firm

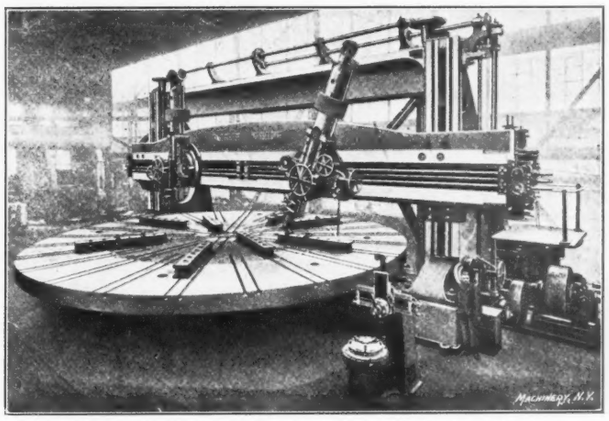


Fig. 1. A Mammoth Boring and Turning Mill with Table 36 Feet in Diameter.

of Ernst Schiess, A. G., Düsseldorf, Germany, and the illustrations are reproduced from the June 20 issue of the *Zeitschrift des Vereines deutscher Ingenieure*. The machine will take in work 39 feet 4 inches in diameter, and 11 feet 2 inches high, the table of the machine itself being 36 feet in diameter. The machine is motor-driven, and the speed of the table varies between the limits of 0.085 to 4 R. P. M. The control of the electrical motor, as well as the feed and speed changes, are all effected from devices placed on the traveling tool heads, in order to eliminate the necessity of the operator descending from the table whenever changes in this respect are to be made, or the machine started or stopped. The firm mentioned has built, in all, nine of these machines. The proportions of these machines are perhaps best exhibited in the half-tone, Fig. 2, this photograph being taken with 227 men sitting or standing on the machine. The total weight of the machine is 330 tons. In the foreground the smallest size of boring and turning mill built by the firm is shown for comparison.

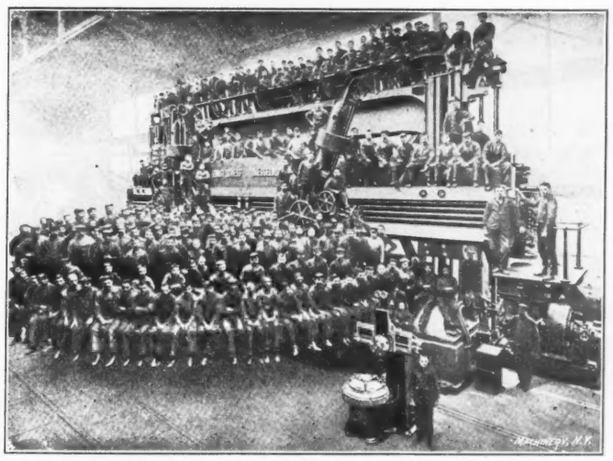


Fig. 2. A Group of 227 Men on the Machine.

HELPS AND DON'TS FOR GRINDING.*

Selection of Wheel.

Don't believe that all materials can be ground equally well with one and the same wheel.

Get the proper wheel for the work.

You would not expect to turn all kinds of lathe work with one tool having only one form of cutting edge. The grinding wheel is a tool for cutting.

Different shapes of work, different kinds of metal, require different cutting edges as well when grinding, as when turning. Different grades and grains of wheels are required for different kinds of work.

Grinding wheels are numbered from coarse to fine, and graded from soft to hard. The grade is denoted by the letters of the alphabet from E to Z.

Don't decide on the wheel without knowing the work.

Spindle speed and character of the material, shape of work to be ground, and surface of wheel in contact are prime factors.

In cylindrical grinding, speed of work, diameter of work and depth of cut must all be reckoned with in the selection of the right combination of grain and grade.

The condition of the machine affects the efficiency of the wheel. Heavy machines with large wheel spindles and massive wheel support call for a wheel different than lighter machines with smaller spindles.

Don't order a certain grade wheel merely because that grade is used on similar work in another plant.

Don't use a hard wheel to economize—it is production you are after.

A hard wheel is more likely to change the temperature of the work or to become glazed than a soft one; furthermore, it requires more power to do the same amount of work.

It is a common error to assume that a wheel for grinding steel and cast iron, chilled iron and hardened steel, must be as fine as the surface desired. A coarse wheel will produce a fine finish if the proper relations between grade, depth of cut, speed of work, speed of wheel, etc., are observed.

When grinding brass and the softer bronzes, the wheel must be as fine as the finish required. Bronzes with "manganese" or "phosphor" permit the use of coarser wheels.

Don't get a wheel made for soft steel for use on hard steel.

For a fine finish on hard stock, a coarse wheel may be necessary, and the harder the stock the coarser the wheel.

When ordering wheels, don't forget the diameter, width, style of face, arbor hole, description of work, speed of spindle, and the number and letter denoting the combination of grain and grade, if known.

The width of the wheel should be in proportion to the amount of the material to be removed with each revolution of the work.

If you reduce the width of the wheel, you must use a finer feed, and consequently do less work.

Mounting.

Never mount wheels without flanges.

Flanges should be, at least, one-third the diameter of the wheel; one-half is recommended. Flanges should be concave—never straight or convex.

Use fiber or rubber washers a trifle larger than the diameter of the flanges, or flanges with soft metal facings.

Hooded machines are desirable when practicable.

Truing.

Don't start work on a new wheel until you are sure it runs true.

Always have a wheel dresser handy for truing wheels for off-hand grinding.

Never use a dresser on wheels that grind circular work on centers.

For truing wheels used on plain cylindrical and universal grinding machines, cutter and reamer grinders, etc., the diamond is recommended. To obtain the best results it is absolutely necessary.

Never attempt to true a wheel for circular grinding unless the diamond is held in a rigid tool-post on the table of the machine. You cannot do good work with such a wheel when it is trued "by hand."

To get a truly ground surface, you must keep the face of the wheel true.

The quality of surface finish is dependent on the conditions of the wheel face and depth of cut.

Speed.

Don't start grinding until you know the speed is right—not "near enough," but right.

Even a slight variation in speed may be the cause of success or failure of any wheel.

Failure is sometimes turned into success by merely changing the speed of either the wheel or work.

Speed up the spindle as the diameter of the wheel is decreased. Approximately the same peripheral rate should be maintained as the wheel wears down.

Complaint is sometimes made that wheels appear to be softer toward the center. Usually this is because the same surface rate of speed is not maintained as the wheel is reduced in diameter. This causes the wheel to wear away faster and appear softer. It is also true that while the grade of the wheel may be uniform throughout, yet the smaller line of contact due to the smaller diameter will cause the wheel to appear softer.

Increasing the speed of a grinding wheel gives the effect of a harder wheel; decreasing the speed gives the effect of a softer wheel.

For surface grinding, it is customary to run wheels at a somewhat slower rate of speed than for general grinding. A speed of 4,000 to 5,000 surface feet is usually employed.

Wheels are run in actual practice from 4,000 to 6,000 feet per minute.

General Suggestions.

Transferring a wheel worn down to a small diameter, from a large machine to a small one, is good practice.

Keep the tickets or tags which are sent on the wheels in a record book, so that if a wheel is not satisfactory, reference can be made to order number when making complaint. It is equally valuable as a reference when ordering duplicate wheels.

Don't use the wrong wheel on a job because it will require a few minutes time to change wheels. A stop watch will prove to you that changing wheels is cheaper.

There is seldom a case where one and the same wheel can be used on all work without a greater loss of time than the change of wheel would involve. Many times, the time saved in grinding a single piece more than pays for changing the wheel.

Considerable difference in diameters of work will affect the cutting quality of a wheel on any given material.

A successful wheel on the small diameters may work much slower on the larger diameters.

The wheel most suitable for work of very large diameter may wear away too fast on work of smaller diameter.

A suitable wheel for small diameters may cause chatter on pieces of large diameters.

Don't grind circular work dry.

A good wheel will grind in water, soda water or oil.

Water keeps the wheel working cool, and increases grinding production.

Soda water keeps the work and the machine from rusting.

Oil in soda water increases the wheel's effectiveness.

The particles from a grinding wheel do not adhere to steel. Don't let any one convince you to the contrary.

Grinding is profitable for removing stock as well as for finishing.

Keep the face of the wheel true and parallel with axis of spindle.

Vibration makes grinding wheels wear.

Keep all rests adjusted close to the wheel, otherwise work is liable to be caught and injury result.

Keep boxes well oiled and adjusted.

When practicable, indicate on each machine the revolution of spindle and size of wheel to be run upon it.

Don't disregard the setting up instructions that go with the grinding machine.

* Extracts from booklet issued by the Norton Co., Worcester, Mass.

HOW TO HANDLE A FILE.*

W. A. KNIGHT.†

Probably no branch of the machinists' trade requires more skill than the proper handling of a file. To make a file cut smooth when desired, and to make it cut where you want it to, and at no other place, is an art worth cultivating by all the younger men of the trade. It is possible to train an apprentice to operate a lathe, planer, or milling machine, and do good work on it, in much less time than it takes to teach him to do good filing. Probably this is the reason that most of the filing and fitting is done in the shops by the older class of mechanics. This article is not directed to them, for doubtless there are many such who can handle a file much better than the writer, but it is assumed that the points herein mentioned may prove of value to some of the younger men of the trade.

Filing a Flat Surface.

In filing a flat surface the choice of file depends on the degree of flatness and finish required. For a really flat surface, the writer would use a square file with which to do the first

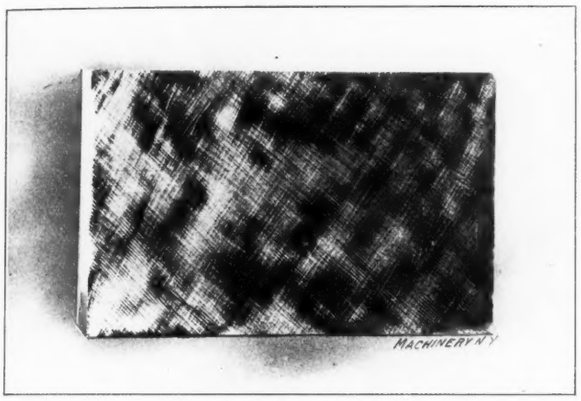


Fig. 1. Cross-filed Flat Surface.

filing, and a pillar for the finishing. If one has to get along with one kind of a file for all kinds of filing, the writer would prefer the square safe edge file to all others. The reason for this is that the square file has more "belly" to it, and possesses greater stiffness in the direction of applied pressure in proportion to its bearing surface on the work than any other, and, being narrow, requires less pressure to make it "bite" into the work.

In order to file straight it is necessary that the file "hold its cut," any slipping or sliding over the surface being fatal to straight filing. Whatever kind of a file is used, the downward pressure should be sufficient to cause the file to bite and hold its cut, and with a wide flat file such as a hand file, or one that has become dulled by use, this pressure becomes so great as to make straight filing extremely difficult. The square file requires less pressure, is under better control, and responds to the "touch" and "feel" of the operator better than any other. The pillar file is next to the square as regards the foregoing points, and for some cases might be preferred. The writer would here offer the suggestion to file makers that for flat surface filing, the hand and pillar files should have more "belly," being thicker in the center than as at present made, and that the curvature be made uniform from point to heel. With such a file we could do more and better work, and do it easier than with the present styles. Another point, but on which there may be some doubt, is that in a double-cut file the cuts across both ways should be of equal depth, so that the diamond shaped squares left by the chisel marks stand out sharp and distinct. The writer can give no definite reason for this, except that he instinctively prefers a file like that to one with teeth having somewhat the appearance of a single-cut file.

To file a surface flat it is necessary to "cross file" it, that is, file it in different directions until the tool marks are eliminated and the desired degree of flatness obtained. This cross filing is most important, and is a prime factor in the production of flat surfaces. By frequently changing the direction of file marks, the operator can see at all times just where the file is cutting. If it is desired to lower any part of the surface after testing with the square, straight-edge, or mating piece, the file should be made to cut across the marks left by the previous filing. The cross marks then serve as an indication of the amount being taken off. After cross filing, the surface will have the appearance shown in Fig. 1.

When using a square or pillar file for the cross filing, it should be given a slight side motion while making the cutting stroke. It should be lifted *clear* of the surface on the back stroke, care being taken not to have it come up with a sweep and down with a sweep, but the path should be like that indicated by Fig. 3. If the surface is to be finished, then go over it lightly in one direction just taking out the cross marks. For this purpose a new file is best, second cut, smooth or dead smooth, according to the finish desired, but previous to using the file, it should be rubbed down lightly with a flat Arkansas oil stone. A new file often has a few teeth projecting above the general surface, especially at the corners, and this light stoning takes them off so that the file is more likely to cut without scratching. It might be mentioned that the last cross filing should be done with as fine a toothed file as that used for finishing, so as not to have deep scratches to take out in the final filing. For this finishing, "straightaway" filing is to be preferred to draw filing, because of being quicker and leaving the corners in better shape than the draw filing; but, of course, there are many surfaces for which draw filing must be resorted to. If the surface has been properly filed, a very few strokes with emery cloth will "lay the grain," giving it a uniform appearance, and with corners sharp like knife edges.

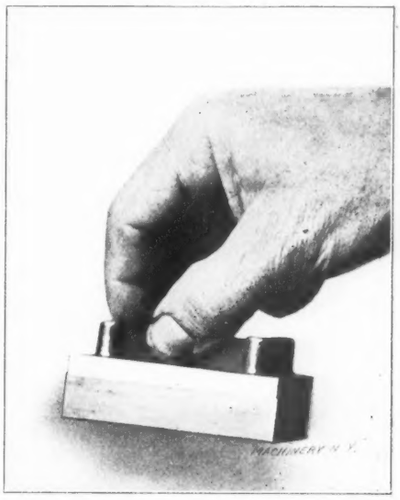


Fig. 2. Example of Cohesion between Two Surfaces, One of which is scraped Flat and the other filed to fit it.

To prevent pinning when filing soft steel, some mechanics use chalk on the file, others use oil. In the writer's opinion, chalk is a poor substitute for oil; the only case where it would possibly have any advantage would be with a dull file. However, one might about as well think of shaving with a case knife as trying to file straight with a dull file. The file is like all other wood or metal cutting tools; if it is to cut where you want it, it must be sharp. Care should be taken, however, not to use too much oil; a good plan when using a fine file is to oil it and then draw it through a piece of waste. This at once cleans the teeth, and leaves sufficient oil on the file. After it has been used a little while, it should be again drawn through the waste to clean out the chips. No file card is necessary.

The half-tone Fig. 2 shows two pieces held together by atmospheric pressure. One piece is a small cast iron surface plate 3 x 2 inches, ribbed as shown, the other is a steel block of the same size, but ⅝ inch thick. The surface plate was scraped to a master plate and the steel block filed to fit it. These surfaces are *dry*, not wiped off with greasy waste, but washed with gasoline and dried with a clean cloth.

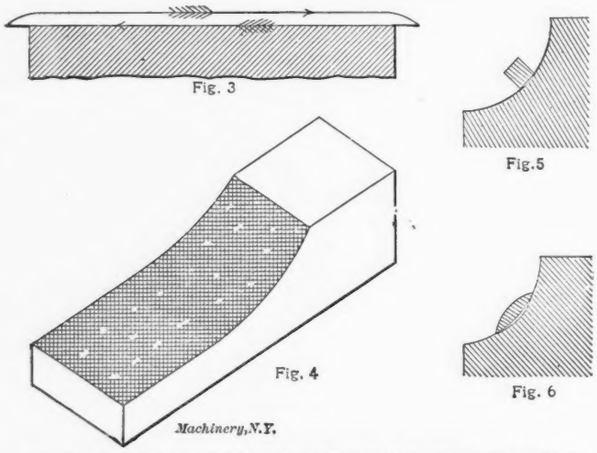
Nearly all of the foregoing can be summed up in a single sentence: *For flat surface filing use a sharp file and localize its cutting action.*

* For additional information on this and kindred subjects see the following articles previously published in MACHINERY: British File-testing Machine, December, 1907, engineering edition; Examining and Testing Files, October, 1907; Making Swiss Files in America, September, 1907; The Making of Fine Tool-makers' Files by American Methods, April, 1905; File Cutting Machine, October, 1903, engineering edition; The File and Filing, February, 1898.

† Address: 206 W. Lane Ave., Columbus, O.

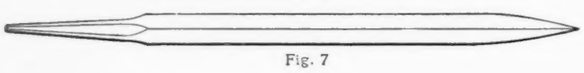
Filing a Concave Surface.

For filing a concave surface such as shown in Fig. 4, an ordinary half round file will do for roughing; outside of that it is a poor tool. A square file, as shown in Fig. 5, is much to be preferred, as it will "lay to the surface," and make it possible to get the surface straight cross-wise with much less effort than with the half round file. The file should be held straight across, and swept round the curve while it is being advanced, sweeping it both ways to insure a smooth curve. To be sure, the file is cutting only on its corners while being used this way, but it is surprising how much work these corners will do, how little pressure is required to make the file cut, and how easy it is to keep it from rocking.



Figs. 3 to 6. Methods and Tools for Filing Flat and Concave Surfaces.

The crossing file is, however, a more scientific tool for this kind of work than the square. It should be used with the flattest side next to the surface, or, in other words, the radius of curvature of the file should be *greater* than that of the surface being swept out, as indicated in Fig. 6. The only difference between this file and the square file is that the former has more bearing surface on the work. The essential point is that the file has a bearing along its two edges, and *not in the center*. After the piece has been brought to shape and dimensions by cross filing, it can be finished by draw filing, using a half-round or crossing file with radius of curvature *less* than that of the surface. It will often be found a help, if there is any tendency to get the surface high in the center, to use a scraper made of a three-cornered file to ease



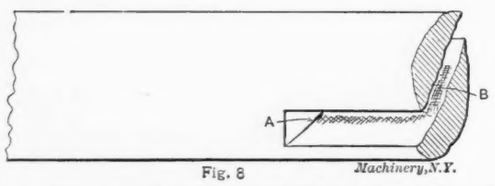


Fig. 7. Three-cornered Scraper made from Old File. Fig. 8. Filing a Rectangular Slot.

off the center a little. The scraper is ground as shown in Fig. 7, and used the same as when scraping out a babbited box. A little oil should be used when scraping steel.

Filing a Convex Surface.

The same general principles as just explained are adhered to in filing a convex surface. If the piece is of such shape that the file can be held at an angle with the axis of the curved surface, that is, not straight across, then the cross filing can be done by making the stroke of the file go partly round the curve as well as across, practically no side motion being given the file. If, however, the nature of the case prevents this kind of a stroke, the file should be held straight across, and then given a little side motion to carry it around the curve, while its motion in the direction of its length is straight across. When the surface is thus properly cross filed, it can be finished by draw filing, if the grain is to run with the curve, or by straightaway filing, if the grain is to be across.

Filing Out a Slot for Boring-bar.

Ordinarily it is a difficult job to file out a square hole or slot through a bar, principally for the reason that one cannot see the place of application of the file. It is a great help after the hole has been roughed out, to take a flat scraper with a good square end, and scrape out the corners and the central portion of the flat surfaces as at *A* and *B*, Fig. 8. The metal can be removed just about as fast with a scraper as with a file (sometimes faster), and by hollowing out the center and corners a little, the file will have a bearing on the outer edges, which renders it easy to prevent rocking. For this work the writer again prefers the square file, and always gives it a side motion whenever possible, cross filing the surface to keep it true. When filing through a hole, use the file without a handle, firstly, because of the danger to the eye should the file handle slip off, and secondly, because it is largely a matter of "touch" to ascertain what the file is doing, and the "touch" is much more sensitive without the handle.

A few good scrapers, say a half-round, triangular, square, flat, and round, of different sizes, with square ends, are very handy tools to have around when doing vise work. They can be used to help the filing along by squaring out corners, easing a place off a little here and there, and will prove time savers in many ways.

* * *

SOLDERING ALUMINUM.

The statement is frequently made that aluminum cannot be soldered, but this is a mistake, and the *Brass World* gives the following information in regard to this question, from an experienee extending over the time that has elapsed since aluminum became extensively used. This experience has demonstrated in the first place that pieces of aluminum can be soldered together; but that aluminum cannot be readily and successfully soldered to other metals. The problem of soldering is not alone that of the solder, but account must be taken of the fact that the surface of aluminum is always covered with a film of aluminum oxide. Even when freshly cleaned, this oxide forms immediately, and being of nearly the same color as the metal itself, it is not visible to the eye.

There is no solder which allows aluminum to be soldered with the facility and success that attends the soldering of other metals. The best solder, however, consists of the following ingredients:

Tin	29 ounces
Zinc	11 ounces
Aluminum	1 ounce
5 per cent phosphor-tin	1 ounce

This solder, the Richard solder, was first made in 1892, and has withstood the test of time better than any others. Many of the so-called aluminum solders have disintegrated within a few years after the joint had been made. The solder may be applied to the parts to be soldered with a soldering iron or blowpipe. It is admitted that the operation of soldering aluminum leaves much to be desired, but the results obtained by the solder mentioned are as satisfactory as any that have hitherto been demonstrated.

* * *

The draftsman who can make satisfactory sketches and drawings without erasures is not yet born, but it is quite possible for all to learn to make sketches and use the rubber so little that erasers are not noticeable. In the first place, avoid the use of hard pencils and hard lines in the preliminary work. In the second place, use special sponge rubber, adapted to the cleaning of the surface of the paper, rather than its removal by friction. A coarse gritty rubber tears away the paper and destroys the surface. Fresh bread is good for cleaning off lines and grime from drawings, but ordinarily it is not convenient to use because of being hard to keep in the right condition, that is, neither too fresh nor too stale. For light erasing on water color work, small pieces of white kid leather from old gloves is recommended. These should be used once only and then thrown away.

SYSTEM FOR THE BLACKSMITH SHOP.

JAMES CRAN.*

James Cran.†

It is not necessary that a system for the blacksmith shop be of the kind usually known as red tape, which often takes more time to handle than the time it saves; but a simple method of keeping track of work, tools, and material will save time and expense.

To begin with, the blacksmith shop ought to be large enough to provide a place for everything in the shape of tools and equipment, and permit everything to be in its place. Forges should be numbered with figures of size and color which can be easily seen from any part of the shop. The forges should be referred to by their numbers, instead of "so-and-so's" forge. This would insure work being taken to the place it was meant for. With each forge there ought to be a tool bench of size and design which would accommodate one full set of blacksmith's tools such as are used at the anvil. Each tool should be marked with its size and the number of the forge to which it belongs, so that each blacksmith will know the tools which form part of the set he is supposed to use, even if they should in any way get mixed up with others. To insure keeping a full set at each forge, it would be well to give each man a list of the tools belonging to the forge at which he is expected to work, with the understanding that he will be held responsible for all tools not worn out or accidentally broken. Any tool worn out or broken should be reported to the man in charge, so that they could be replaced as soon as possible. Having a full equipment at each forge would be a decided advantage to new men starting in to work, because, as anyone who has ever been employed in a blacksmith shop knows, as soon as a blacksmith leaves the shop in which he has been working, he is no sooner gone than there is a raid upon the tools he used, and it usually takes but a short time to have them exchanged for the poorest tools in the shop, or, perhaps, just removed without any attempt at replacing. When a new man comes along, he is heavily handicapped, having the worst tools in the place to work with, and it sometimes takes weeks before he has a chance of showing what he can do.

It would be well, in arranging forges, to have them so that light work could be done at one end of the shop, medium work in the center, and heavy work at the other end, so that trip- or steam-hammers could be installed in the most convenient places according to their capacities. Every shop ought to have one or more sets of hammer tools, such as spring swages, spring fullers, bolsters, V-blocks, drifts, hacks, and breaking-down tools, which could be classed as general tools and used at any hammer, and kept on a rack where they would be most convenient. Special and larger tools than those forming sets for forges could be given out on the check system, which is common in most manufacturing plants where tools are given out from the tool-room.

To keep track of stock, it would be well to have each kind or grade marked on the end of the bars with different colors. Thus wrought iron may be marked red; Norway iron, blue; machinery steel, white; and so on until all the different grades are marked, care being taken to cut from the end not painted. When a blacksmith starts on a new piece of work he should be furnished with a card for stock to be used, along with his time card. Stock cards could be printed forms to be filled in and signed by the various hands they would pass through. The following outline would cover the most essential points: Date of issue, order number, workman's number, name of pieces to be made, number of pieces to be made, grade of stock to be used, size of stock to be used, amount of stock issued, amount of stock returned, amount of stock used, and date when work is completed. The card should be signed by the man in charge of the stock and the foreman of the shop, before being sent to the stock clerk.

Piece work is preferable to day work when the number of pieces to be made is such that it can be done to advantage, as it insures the best men getting the most compensation, especially if there is no limit set on the amount they may earn. This is a very important point. It is by no means an uncommon occurrence for a piece of work to be done the same way, and remain at the same price for years until some one comes along who uses a little more common sense than the average man. He sees a way of doing it to save time, and will perhaps turn out double the amount of work as compared with what has been done in the same time before. The result is that he earns on piece work 100 per cent more than the other men have earned. He may be paid for the first lot without any comment being made, but by the time the next lot is to be made, more than likely the price is cut in two, and another man gets the job which is nothing but taking an unfair advantage of a good workman, and does not encourage him to bring out his best ideas. If a man can make two pieces in the time it used to take to make one piece, it means a saving of 100 per cent in fuel. If the manufacturer has a profit on one piece, it is doubled if two pieces are made at the cost of one piece, which, if looked at in the proper way, would be an advantage to both employer and employe.

When day work is the rule, it is quite common to have a scale of wages, and all men at the same class of work are paid at the same rate. One man might be capable of doing considerably more work than another, but at the end of the week they both receive the same amount of compensation, which is anything but encouraging for good workmen. To a great extent this is responsible for the blacksmith's present lack of pride in his work, a pride which used to be common amongst the old-time mechanics. On the other hand, some men seem to worry if they think they have done a little more than their pay calls for; but this class seldom has much pay to call for.

It is poor system where each piece of work is given out with instructions how each detail has to be done, as it leaves no chance for improvement or for getting the ideas of the workman. It is a foreman's place to help his men when he finds that they need assistance, and give them instructions when necessary.

To keep track of the different kinds of tools for lathes, planers, etc., which are usually forged and marked in the blacksmith shop, it would be well to have the different brands of steel of which they are made numbered instead of being marked with the initial of the brand. Quite often two or more brands have the same initial, and are liable to get mixed. If marked with numbers, there would practically be no limit to different brands which could be handled without confusion. The blacksmith who forges the tools should have a list of the brands of steel used with the numbers representing them, together with the working instructions which the makers of high-speed steel usually send out to their customers. The system here outlined may be added to or changed to suit circumstances. On the whole, it would take but little time to handle, would increase the efficiency of the blacksmith-shop, would save time and worry, and be an advantage to all concerned.

[In the course of his article, our contributor states that it is poor policy to have each piece of work given out with

* Address: 916 West Third St., Plainfield, N. J.

† James Cran was born on a farm in Aberdeenshire, Scotland, in 1868. At the age of eighteen he commenced to serve an apprenticeship in a small country blacksmith shop in Scotland, where he remained for two years after having finished his apprenticeship. After that he was employed by two Scottish makers of iron golf clubs, until he arrived in the United States in 1896, where he was at first employed with A. G. Spalding & Bros. for about four years, the greater part of the time as foreman of the blacksmith shop. He was one of the first, if not the first man, in the United States engaged in making forged iron golf clubs. Later he has been engaged with the Moore Drop Forging Co., Springfield, Mass., the Holt Mfg. Co., Stockton, Cal., and the Electric Vehicle Co., Hartford, Conn. At present he is foreman of the blacksmith shop at the Pond's Works of the Niles-Bement-Pond Co., Plainfield, N. J. Mr. Cran's specialty is machine blacksmithing, but he has had wide experience in almost all branches of forge shop work.

instructions as to how each detail is to be done. This seems to be diametrically opposed to the principle of the Taylor system of shop management. Examining the conditions and the subject our contributor deals with, however, we will find that his statement is not referring to shops having an actual planning department, such as is required by the Taylor system, but the ordinary shop organization is referred to. In such a case it is very seldom that the foreman has the time and the detailed information required to give instructions of such a character as would insure the highest efficiency; and, then, it would be better that no attempt be made to give detailed information unless the workman is likely to fail to carry out the work entrusted to him satisfactorily if not instructed.—EDITOR.]

* * *

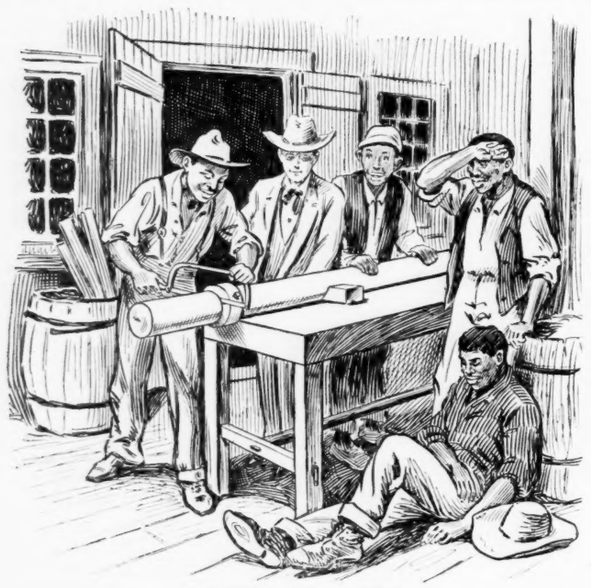
SAM AND HIS HACK-SAW MACHINE.

A. P. PRESS.

When I was working at the old Mason Machine Co. we had a man named Sam Graw, Sunny Sam, we used to call him. He was a rough-and-ready sort of a fellow, a good mechanic, and he could always crawl out of a cavity all right. He could use a micrometer as well as the best of them, but if he didn't have one handy a two-foot rule would do as well.

The firm used to do a lot of cotton work down South, and Sam was the "setter up," that is, he used to go for the firm with the first shipment to lay out the mill, set up the looms, and other machinery, as fast as they came along, and stay until everything was in good order.

Sam has just got back from a trip, and he told me this yarn. He had got most through on the job and one day about five o'clock they came over from the next mill and wanted him to come over at once. They had got into a mess. It seems they



"He worked them all night."

had ordered a 6-inch shaft 8 feet 10 inches long, and it had come 10 feet 8 inches long, and they could not use it without cutting it off. There was no shop within thirty miles that could handle a 6-inch shaft that could help them out anyway. Sam thought a minute and said: "Sure thing." "How long will it take?" "Ten hours or less." "What help do you want?" "Just four good darkies" (all the cheap help were negroes), said Sam, "and it will be ready at 7 o'clock to-morrow morning." "Well, that is easy,' said the superintendent, and he sent in the men.

Sam put a collar on the shaft, and started the first man at work with a 10-inch hack saw he had in his kit. He ran him fifteen minutes, and then took No. 2 and so on through the four; he worked them all night, while he sat on a keg and urged them on. When that 10-inch saw got in the center of the 6-inch shaft it was a pretty short pull, but Sam kept them at it, and at 6.30 A. M. the shaft came off.

The superintendent was a pleased man when he saw it. He gave the darkies all a day off, and Sam an X, and the whole gang was happy.

USING A SLIDE RULE FOR OBTAINING ANY ROOT OF NUMBERS.

HJALMAR FAGERSTROM.

Some years ago the writer found a convenient way for figuring out on a regular slide rule any root of any number, using for this means the scale of centimeters commonly found on the vertical edge of the slide rule. An example will best show how this is done. Suppose that it is required to find $\sqrt[5]{87}$. If there are no logarithmic tables at hand, it may be difficult to find the root, but it can be figured near enough for most cases with the slide rule, even without employing the logarithmic scale of the rule. Before, however, the root can be determined by the means the writer is about to explain, an improvement must be made on the slide rule runner in order to insure fair accuracy. The runner must be marked with an index line in line with what would be the zero line on the centimeter scale, the index line on the glass of runner being over the graduation 1 on the rule when this line is marked, as is plainly indicated in the accompanying

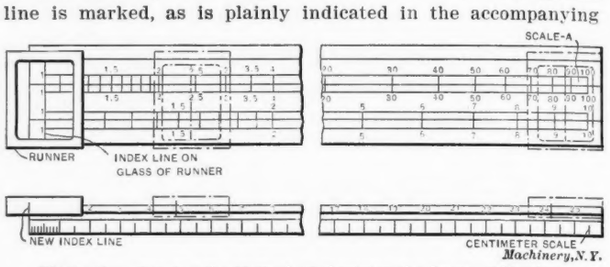


Illustration showing the Method of obtaining the Roots of Numbers.

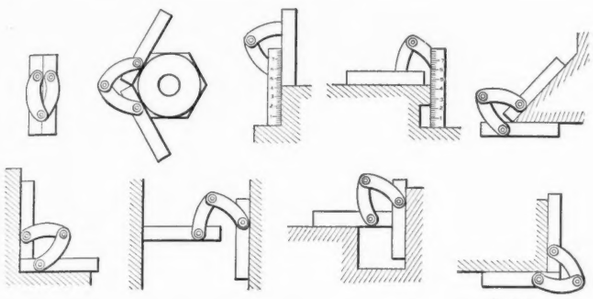
engraving. Now, if it is required to figure out $\sqrt[5]{87}$, move the runner until the index line comes over 87 on the scale A (see engraving). When this is done, turn the rule and read off on the centimeter scale the graduation in centimeters opposite that index line which has just been marked on the side of the runner. The graduation opposite this index line would be 24.25. Now assume that 24.25 is the logarithm for 87, then divide 24.25 by 5, in which case we obtain 4.85. Now move the runner until the index mark on its side points to 4.85 on the centimeter scale. On the scale *A* under the index line of the runner we can now read off the figure 2.44, which is equal to $\sqrt[5]{87}$.

[It may be interesting to point out the reason why the method employed by our correspondent will give the correct root of any number as indicated. The slide rule is so graduated that the various distances along the scales from the first graduation represent the logarithms of the various numbers marked on the slide rule. Consequently, when we move the slide from the figure 1 up to the figure 87, we move a distance corresponding to the logarithm of 87. To find the logarithm for $\sqrt[5]{87}$, we divide this distance in 5 equal parts, and one of these parts represents the logarithm for $\sqrt[5]{87}$. The distance we have moved the slide, when we moved from 1 to 87, is represented by the length of the centimeter scale from the end of the rule up to 24.25. Therefore, we divide this distance in 5 equal parts, which gives us 4.85, which corresponds to the position where the slide will have to stand in order to get the logarithm for $\sqrt[5]{87}$. It is clear that powers of certain numbers can be obtained in a similar way. Some improved slide rules would not permit this method to be used, however, with the ordinary runner, as the distance which the rule projects outside of the graduation 1 on the top of the rule is so long that the runner does not extend over the end of the rule when indicating 1; the graduations on the centimeter scale, however, commence at the end of the rule, and it is not possible to get an index line on the side of the runner, opposite the zero line in the centimeter scale. For numbers over 100 this method becomes rather complex, as it necessitates adding one full length of the scale, or 25 centimeters, to the figure read off on the centimeter scale, for each two additional figures in the original number given. It is rather unprofitable to discuss this complication of operations at length, as it is far easier to use the logarithmic scale of the slide rule, and obtain the actual logarithm required itself.—EDITOR.]

ITEMS OF MECHANICAL INTEREST.

A SIMPLE TOOL FOR MEASURING ANGLES.

The accompanying illustration shows a very simple, but at the same time, a very ingenious tool for measuring angles. Strictly speaking, the tool is not intended for measuring angles, but rather for comparing angles of the same size. The illustration shows so plainly both the construction and the application of the tool, that an explanation would be superfluous. It will be noticed that any angle conceivable can be obtained in an instant, and the tool can be clamped at this angle by means of screws passing through the joints between the straight and curved parts of which the tool consists. Linear measurements can also be taken conveniently,

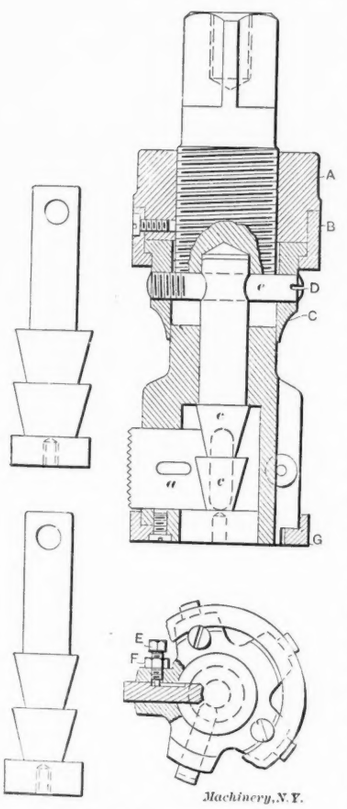


A German Tool for Comparing Angles.

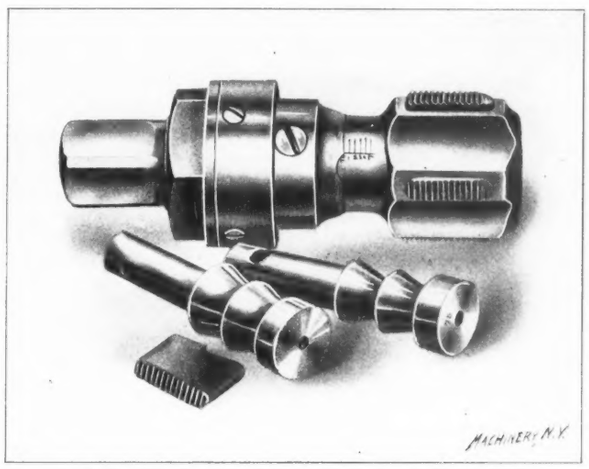
one of the straight arms of the tool being graduated. As both of the arms which constitute the actual angle comparator are in the same plane, it is all the easier to make accurate comparisons. This tool is of German design, and is manufactured by Carl Mahr, Esslingen a. N.

GERMAN DESIGN OF ADJUSTABLE TAP.

An interesting adjustable tap has been brought out by the Präzisions-Werkzeug und Maschinen-Fabrik Richard Weber & Co., Berlin, Germany, and has been illustrated and described by the *Zeitschrift für Werkzeugmaschinen und Werkzeuge*. The general appearance and construction of this trap is illustrated in the accompanying halftone and line engraving. The principle of the tap is plainly shown in the line engraving, Fig. 2. The special feature of this tap is the use made of stems or spindles, having different sized steps, against which the back of the threaded chasers, which enter into slots in the tap, are placed. The taps are provided with five chasers or inserted blades. With simply a single set of chasers and a number of different stems or spindles, various sizes of tapped holes can be taken care of. The tap can also be adjusted within certain limits, using the same spindle, by turning the nut *A* on the shank of the tap, whereby, through the action of the intermediate parts *B*, *C*, and *D*, the stem can be moved so as to force the chasers outward the required distance. The chasers are clamped in place, when adjusted, by screws *E*, provided with a check nut *F*. The ring *G* at the lower end of the tap, which may be provided in special cases, serves the purpose of guiding the tap concentric in the drilled hole. The neck of the tap is provided with graduations, so that the amount of adjustment can be read off directly, when made. While the principle of this tap merits



Section and Elevation of the Tap.

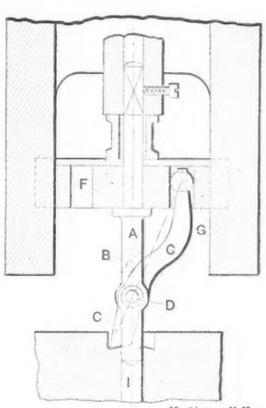


The Adjustable Tap, and Stepped Stems for Varying the Size.

attention and has certain points in its favor, it seems, however, that the design is rather complicated and that the expense of making taps of this type would be so high as to prevent them from coming into general use. No doubt, however, the principles could be employed to advantage in a simplified design, and in such a case it would not be impossible that a tap of this type would have a successful future.

DEVICE FOR DRILLING SQUARE OR IRREGULARLY SHAPED HOLES.

The accompanying illustration shows an interesting little device, described in the May 25, 1908, issue of the *Zeitschrift für Werkzeugmaschinen und Werkzeuge*. The device, as shown, is attached to the spindle of a drilling machine, and consists, in main, of a cam *G*, a lever *C*, and a stiff guide bar *A* through which a slot *B* is cut. In this slot the lever *C* is inserted and held in place by the screw *D*. The lower end of this lever is ground so as present a cutting edge to the work, while the upper end is provided with a ball-shaped projection, which slides in the groove *F*, in cam *G*. this groove being a form corresponding to the outline of the hole to be machined, only on a larger scale. The cam is stationary, while the lever *C* is rotated by the arbor *A*. It is evident that when rotating, the upper end follows the path of the cam-groove *F*, thereby causing the lower end with its cutting edge, to follow a path similar to that of the cam-groove, and thereby producing a hole of the required form and of the size determined by the proportion between the lengths of the upper and lower lever arms. While the cam *G* is stationary as far as rotating motion is concerned, it follows, of course, the motion of the tool in an axial direction. A circular hole is first drilled in the piece where the irregular shaped hole is to be formed, in order to provide for the guiding of the bar *A* which enters into the hole *I* as indicated, and acts as a pilot.



Attachment for Drilling Holes, the Shape of which Depends upon the Shape of the Cam-groove F.

* * *

A concrete oil tank at San Antonio, Texas, has been in service at the San Antonio gas works, holding heavy Texas oil. It has shown no leakage whatever, which contradicts the general belief that oil destroys the cohesion of concrete.

Copyright, 1908, by THE INDUSTRIAL PRESS.

Entered at the Post-Office in New York City as Second-Class Mail Matter.

MACHINERY

REGISTERED IN UNITED STATES PATENT OFFICE.

DESIGN—CONSTRUCTION—OPERATION.

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

49-55 LAFAYETTE STREET, CORNER OF LEONARD,

NEW YORK CITY.

Alexander Luchars, President and Treasurer.
Matthew J. O'Neill, Secretary.

Fred E. Rogers, Editor.
Ralph E. Flanders, Erik Oberg, Franklin D. Jones, Associate Editors.

The receipt of a subscription is acknowledged by sending the current issue. Checks and money orders should be made to THE INDUSTRIAL PRESS. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Single copies can be obtained through any newsdealer.

We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

AUGUST, 1908.

PAID CIRCULATION FOR JULY, 1908, 21,145 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

THE ECONOMICAL LIMIT OF INCREASED PRODUCTION.

In a letter published in the present number, a correspondent relates an experience intended to indicate that increased output at the expense of the tools employed is not always profitable to a manufacturing concern. The problem of increased output, and its economical relation to the best use of the machines and tools employed, is one of the most important in any successfully conducted shop; and, at the same time, it is one for which it is difficult to lay down absolute rules on account of the many different conditions involved. A case similar to the one referred to by the correspondent occurred in one of our largest manufacturing concerns. A new foreman was engaged to take charge of a certain department, who was known as a "hustler," and no doubt he well deserved the title. After having taken charge of his department, his first efforts were directed to increasing the output, as he received a certain percentage on the savings effected. There was no doubt that he did greatly increase the output, and that the labor cost of the articles manufactured was placed on the company's books in figures considerably smaller than before, but at the same time the "unproductive" labor cost of the shop increased materially. The number of tool-makers employed making tools and repairing machinery and fixtures for this particular department, had to be increased, and as they were paid considerably higher than the cheap help engaged directly in manufacturing, a considerable part of the profits of the increased output were required to pay the increased expense for tool-makers. It may also be surmised that the machines in the department had to be replaced with new ones several years earlier than would have been the case if they had not been worked somewhat beyond the limit of their normal capacity. Although machines are inanimate and not affected by fatigue, as is a human being, every machine seems to have a definite capacity limit, beyond which the expense of upkeep and loss of time because of breakdowns make the swifter pace unprofitable. The most successful shop foreman is not he who can increase the output indefinitely, but the one who understands when this economical limit has been reached, and possesses sense and independence enough to stop at that limit.

MAKERS OF SMALL TOOLS SHOULD KEEP IN CLOSE TOUCH WITH USERS.

We recently received a contribution on the construction of brass threading dies in which numerous points were brought out of practical value to tool makers and users of such dies. In the course of the contribution the writer stated that the company with which he was connected, although a large user of dies, had been unable to buy chasers which answered its requirements, and was forced to make its own chasers in order to get satisfactory results. The conditions affecting the action of brass threading dies are much different from those affecting dies used on steel or iron, which are of fairly uniform texture; for a die that will cut a smooth thread on a piece of machinery steel will, nine times out of ten, answer the requirements of most users of dies on steel or iron. This, however, is not the case with brass work. "Brass" is a term roughly covering a multitude of alloys. Its constituents are almost infinitely varied, and it runs in hardness from material so soft that it can be almost dented with the finger nail, to grades which can scarcely be touched with the best steel tools, so that a set of chasers which cut the soft grades easily and smoothly will not work well on other grades.

It is therefore advisable for manufacturers of thread-cutting tools to study carefully the actual conditions affecting the manufacture of brass goods. It is not sufficient to test their chasers on a piece of brass tubing of the best free-working stock, as that is a grade of metal seldom found in commercial brass work. The makers of standard small tools are apt to think they possess nearly all the knowledge on the construction of thread tools that is required for various shop conditions; but in some cases small-tool makers can perhaps obtain valuable information by keeping more closely in touch with the requirements of their customers. Instead of putting a customer down as a mere "kicker" because he complains that a tap or die does not work well, investigate his complaint and find out what the actual conditions are, so that the product can be improved to meet the requirements of all users.

* * *

DRAFTING AS PRODUCTIVE LABOR.

In the April issue of the engineering edition of MACHINERY, an editorial appeared entitled "Economy of Non-Productive Labor," and a specific case was cited to illustrate the argument advanced. There is one phase of machine shop work where we find that greater economy doubtless could be arrived at by introducing a slightly greater amount of non-productive labor, and eliminating a great deal of time wasted by the productive labor in the shop. The writer's experience in some large drafting-rooms, as well as information obtained in regard to others, indicates that it is quite common practice to make jig drawings in assembled views only, and to put all the dimensions directly on the assembly drawing, making no detail drawings whatever; and the argument advanced in favor of this practice is that experienced pattern-makers and tool-makers, who are, as a rule, the only mechanics who will work on the tools, will find no difficulty in reading the assembly drawing, and that, as the drawing is used but once, it would be a waste of time to have the draftsman detail the parts.

In the case of a very simple jig this is undoubtedly true, but in more complicated ones there can be little doubt that the comparatively small expense required for the draftsman to detail the jig will be many times saved in the shop, for the pattern-maker or tool-maker will not have to spend a number of hours puzzling over the drawing, and even then being liable to make a mistake. This is another case where a slight extra amount of non-productive labor, judiciously expended, will save a large amount of outlay for so-called productive labor.

In two large shops within the writer's own experience, the recent practice in one was to detail all jigs, and in the other to make assembly drawings only, and the difference was surprising in the number of questions asked by the shop regarding the design of the jig in cases when they were detailed and when they were not. When assembly drawings were sent directly into the shop, hardly a jig passed through its regular course through the shop without the foreman of the tool making department, or some of his men, coming into the drafting-room to ask half a dozen questions. When the drawings were detailed, hardly a question was ever asked.

SIMPLICITY IN MACHINE TOOL DESIGN.

W. T. SEARS.*

Nearly every type of machine tool seems to have to go through at intervals, a period of extreme complication, in which it becomes loaded down with automatic trips, complicated devices for movements in various directions and numerous other mechanisms, the utility of which, in actual practice, is questionable, although for the time being, and in a great many cases, they undoubtedly make for the salesman good "talking points."

These devices, if inexpensive and not liable to get out of order, are oftentimes useful, and this may be particularly true where a great deal of duplicate work is to be done, especially if these devices are properly fitted for this repetition work. The fitting up of the machine in this manner is perhaps a good thing also, in that it may tend to advance the general usefulness or efficiency of the tool, even if, later, the complicated parts are omitted. It has at least helped to show how far to go, through having gone too far.

Unfortunately, however, in this last case the knowledge has been arrived at, at the expense of the purchaser of the machine, who, in place of getting a machine equipped with many improvements, receives on the contrary, one that is not as good as if the "improvements" had been omitted entirely. They thus represent additional money that has been spent to a disadvantage instead of to advantage, and have actually handicapped the more simple original machine that could have been obtained by a smaller investment. It is safe to say that no machine tool builder knowingly gives a purchaser something for nothing, and the improvements must be paid for. If the price is the same for the new machine with the new features, as for the old machine without them, the probabilities are that the former has been altered and cheapened in some other direction.

There are several points having considerable bearing on this subject which, I believe, have often been overlooked: for instance, when purchasing a machine costing say $2,000, the buyer may be convinced by salesmen that for $200 more he can get a machine which will more than pay for the additional investment. While this, of course, may be true, at the same time attention should be called to what is often the case, which is that it may be a device which would practically never be used, and therefore the $200 is virtually thrown away, in that no reasonable return is obtained for the investment.

Considering this along a little different line again, the purchaser may be convinced that it is a good device or be willing to take a chance, and the machine is ordered with the idea in the purchaser's mind that in case this $200 device did not work satisfactorily, it would simply be a loss of that amount and that would end it.

This is, perhaps, the view most commonly taken and is a very wrong one, for as a matter of fact, the $200 investment may have put a device on the machine which interferes with the regular movements, either by making them unhandy to get at or weakening them through change of design which the new device necessitates.

Another point is that by getting out of order it may lay up the whole machine. It may get out of order through use or abuse, but if this occurs at all frequently, it can readily be seen that the total efficiency has been reduced in place of being increased, unless the saving effected by it while in working order is very great indeed. It often takes considerable time for the testing or proving of the above statements, but that they are correct is proved every day in the history of machine tool design, if in no other way than by the returning of the tool designer to simple forms.

A number of concrete instances can easily be quoted from the writer's experience. For instance, take a planer design with a greatly increased speed on the idle part of the stroke which is obtained by changing from a moderately fast to a very fast speed shortly after the reciprocating part has been reversed. This, by figures, will show a saving for a long stroke, but it was found in actual practice, in the case in mind, that the work requiring a long stroke where this saving could be made, was the exception, and as a result the machine was returned at a moderately fast speed all the time, and the high speed not used at all.

In other words, the money invested for the high return was not only thrown away, but the return actually used was less than on a standard machine with a single return speed. The above is a case where additional money spent proved to be in actual practice, a handicap on what should have been the original investment.

On another machine which the writer has knowledge of, a fast power traverse was called for, for doing a certain class of work. In order to put this fast traverse on, it was absolutely necessary to change the design of the machine quite materially and add considerably to the cost. The machine itself was a simple one. It had gone through years of improving and testing, and its parts were all well proportioned and well designed. The additional parts required for the power traverse were also well designed, but from the nature of the machine they had to be somewhat complicated. The machine was small, and the advisability of the power traverse was much questioned. However, it was put on and worked very satisfactorily.

After the machine was put to work the operations were timed and it was found by actual experiment that the time saved by having this power traverse was about half a minute on a half hour's job. The amount saved in energy was, of course, also very slight, and while the impression conveyed to a casual observer was favorable, it is extremely doubtful if the fast traverse of this tool will prove economical in any way. Taking it in actual figures, and along one of the lines attention has been called to, if this additional mechanism lays up the machine for a day, as is quite possible, it will more than counter-balance the time saved in four months by the use of the power traverse.

Of course, if the machine were a large one and the amount of distance of travel of parts required, considerable, these figures would be entirely changed and the investment would unquestionably be a good one; but it is extremely doubtful if on the small machine it is either economical or advisable, and it is pretty safe to say that on such a machine it is a mistake. These are exceptional cases, but not by far as uncommon as many suppose, and these exceptional cases are the very ones that bring out the weaknesses of many so-called labor- and time-saving devices, and should act as warnings to any one about to purchase machinery and lead him to investigate such devices carefully and thoroughly.

A real improvement, one that actually saves time or labor and is neat and simple in design and operation, is one that can be easily recognized as such by any man capable of intelligently purchasing a machine tool. Such a device ought to command its proper price, and will pay good interest on such price.

Summarizing the above objections to new special features, we have: First, that a special device may be used but seldom; second, that it may break down and hold up the entire machine; and third, that its installation may be detrimental to the design of movements now on the machine, which are already recognized as good.

An arrangement which appears to come under any of the objections in the above summary should be bought with caution and only after very careful consideration.

* * *

A quick installation of a steam heating equipment was recently made in a building at Trowbridge, England, in which some public meetings were to be held. As stated by the *Engineering Record*, the order for the work was given on Saturday at 9.45 A. M. and at 7.30 A. M. the following day the work was completed, including the installation of a steam boiler with an independent pump for the return of condensation, all necessary fittings, reducing valves, steam traps, etc., 1,080 feet of cast iron feed pipes with 40 fittings, and 1,140 feet of wrought iron pipe with 176 fittings. The work was accomplished by 30 men working continuously all the time, and involved the making of 159 joints in cast iron pipe, over 500 joints in wrought iron pipe, and the handling of 12 tons of material.

* Address: 21st and Callowhill Sts., Philadelphia, Pa.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

The Cape Town to Cairo Railroad in Africa, which, when completed, will be one of the important Trans-Continental railways of the world, at the present time requires the completion of less than 700 miles to enable travelers to make the journey from Cairo to Cape Town by rail.

The Controller-General of Patents in Great Britain states that the great inventive activity in connection with the motor car industry which has produced such a large number of applications for patents in recent years, now shows signs of falling off. The decrease in the number of patents relating to automobile construction was not less than 35 per cent during last year.

New York City is spending $161,000,000 to increase its water supply. A great aqueduct will be built from the Catskills, and the water shed of a large area will be made available for the city water supply. In the matter of length, the aqueduct building for Los Angeles, Cal., is greater, however. It is to be 215 miles long and will tap the snow-fed Owens River and its tributaries. Its capacity will be 400 cubic feet of water per second.

As an example of the present realization of the value of the enormous water powers of the streams in northern Europe, it is stated by *Engineering* that the building of a large power station in Lapland, in the north of Sweden, is likely to be started during this summer. The power available at the falls near Brännland, which are to be utilized, is estimated at 81,000 H.P. It is not stated for what purpose the power is intended to be used.

An indication of the expense of repairs attending the running of motor cars and motor omnibuses is given by the report of the General Omnibus Company of Berlin, Germany, which is the largest transport undertaking of its kind in Germany, and which carries about 134,000,000 passengers a year. According to this report, the cost of maintenance and repairs of motor omnibuses reaches yearly nearly 50 per cent of the original purchase price.

A news dispatch states that the Southern Pacific R. R. is contemplating the boring of a long tunnel through the Sierra Nevadas, and that the surveys and estimates have been completed for some time. This tunnel will be between Truckee and Blue Canyon. It will be about 7 miles long and the total cost will aggregate $11,000,000, at least three years being required to complete the work. This will be the longest tunnel in the United States, and, with three exceptions, the longest tunnel in the world.

The Holland-American liner *Rotterdam* reached the port of New York City on June 22 on her maiden trip. This vessel is one of the largest that has ever been built, being 24,170 gross registered tons. The principal feature of the ship is the large amount of space placed at the convenience of the passengers. The state-rooms are said to be larger than those of any steamer that has entered New York harbor, and the promenade deck makes a record for size with 12,000 square feet of walking space. The total accommodations provided for are 525 first-class, 515 second-class, and 2,500 third-class passengers.

A very peculiar accident occurred on the Long Island R. R. June 22. A passenger train was approaching the Long Island City terminal when a brake-rod broke and the end falling down caught on the ties, doubled up, and twisted the handle of the train pipe valve around and closed it. When the engineer attempted to apply the brake he found that he had lost control of the train. Vigorous whistling alarmed the conductor and trainmen, who applied the emergency brakes, but too late to prevent disaster. The train crashed into the station, knocking down the bumping post, derailed the engine and demolished the side of the station. Fortunately no one was seriously injured.

The Singer Building tower, 612 feet high, and the Metropolitan Life Building tower, 693 feet high, are soon to be put in the shade by a building to be constructed on the site of the Equitable Life Assurance Society Building on the block bounded by Broadway, Nassau, Pine and Cedar Sts., New York. This building is to be 909 feet from the sidewalk, exclusive of the flagstaff. The flagstaff will be 150 feet higher, making the total height of the building from the sidewalk to the top of the flagstaff 1,059 feet. The main building will be thirty-four stories high. Superimposed on the main structure will be another with smaller base about fourteen stories high, and springing from the center will be a tower of another fourteen stories, making the total height in stories sixty-two. Thirty-eight passenger elevators will be provided.

Small producer power plants are growing in favor, especially in the Middle West. They have the merit of producing power at low cost for fuel and requiring a minimum of attention. An example is the plant driving the shop of the Mechanics Machine Tool Co., Rockford, Ill. A Fairbanks-Morse 50 horse-power motor was installed, and one of the mechanics working in the tool-room is paid 50 cents a day extra for running the machine. He comes to the shop half an hour before starting time and spends about another half hour during the day attending to the plant. Otherwise he works in the tool-room all day long. A car-load of anthracite pea-coal costing $163.24 was put in November 1, 1907, and lasted until June 1, 1908. Since January 1 the plant has run only five days a week. The cost for power in labor and fuel thus figures only about $260 for seven months power.

A Milan correspondent to the *Times Engineering Supplement* states that official trials of the De Forest wireless apparatus for telephonic service have recently been made in the presence of officers of the Italian navy. The apparatus was installed on one vessel, and the vessel put to sea, while communication was entered into with another vessel remaining at anchor in the harbor. Communication was maintained constantly, even when the vessel passed a chain of mountains enclosing the gulf where the harbor is situated. At intervals, several cannons were fired to ascertain if atmospheric disturbances had any influence on the working of the system. At a distance of 20 miles—the greatest distance tried—telephonic communication was regularly maintained. The results were satisfactory, and wireless telephone apparatus will be installed in some of the vessels of the Italian navy.

A hydro-electric power station, using the highest head of water in the world, has lately been designed by Aktiebolaget Vattenbyggnadsbyran, Stockholm, Sweden, for a large factory in Norway. The water is taken from a large mountain lake 3,536 feet over sea level, from which the water is brought by a tunnel 7 miles long, supplying six turbines of from 12,200 to 14,600 H.P. each. The total head is 3,287 feet, which is 72 feet more than the highest head hitherto used for power purposes. The largest diameter of pipe used for conducting the water will be 4 feet 6 inches, and the pipes will be of seamless tubing. The undertaking is one of the most remarkable engineering feats of our time. Norway is rapidly making use of its enormous natural resources in water power, another power station to supply 70,000 H.P. being built, the head here used, however, being only 84 feet.

Experiments carried on by the National Physical Laboratory, in Great Britain, indicate that steel imbedded in concrete is not influenced on its surface either by moisture or by the concrete itself. Specimens of both finished and rough steel were imbedded in concrete in December, 1906, and in

April this year one of the concrete blocks was broken up. On examination, the specimens of steel showed no trace of action by the cement or otherwise. The finished specimen was practically as bright as when put in, and the scale on the rough specimen was undisturbed. To test the possibility of any slight action, the surface of the turned specimen was polished and etched, and examined under a microscope side by side with the specimen of the same metal cut from the center of the bar, but no difference could be detected, and the conclusion is that in sixteen months, at least, no action takes place on steel when imbedded in concrete.

Some interesting experiments regarding the effect of artificial light on vegetation are related in the June issue of the *Electrical Magazine*. A French scientist has for the last two years made repeated experiments regarding the effect of various lights on the growth of plants which were subjected to red, green, blue, and white lights, the conditions otherwise being similar. Under the effect of red light it was found that certain vegetables grew fifteen times as fast as under blue light. On the other hand, the experiments proved that blue light has a remarkable preservative power on growing vegetation. It is recorded that an oak tree planted two years ago has kept its first leaves, which are now as fresh and vigorous as when they first appeared. In the same way, ripe fruit, it is declared, can be kept fresh under a blue screen for several weeks without decay. The facts disclosed by these experiments are expected to find a wide application, and to be of industrial importance.

Statistics collected by the United States government show that the nation has consumed about 7,000,000,000 tons of coal up to the present time. In 1908 the consumption was more than 400,000,000 tons. During the past ten years nearly as much coal was used as had been used during the preceding century. In view of the limitation of our coal resources and the enormous waste in the utilization of the heat energy of coal, there is no greater problem to-day than that of increasing the efficiency of coal utilization. As used at the present for heat, light and power, the losses are so great that less than 5 per cent of the total heat value of coal is converted into useful work in the manufacturing plant. The best and largest power plants utilize only about 10 per cent of the energy, while in railroad operation only from 3 to 5 per cent of the coal value is realized for hauling trains. It is estimated that only one-seventh of 1 per cent of the fuel value is actually converted into light in an electric incandescent lamp. Nearly 2,000,000 horse-power in the form of gas is allowed to escape from the blast furnaces of the country. This waste, however, is being rapidly checked by the installation of gas engines.

Comparatively little has been published in the United States regarding the Renard road train, intended for use on ordinary highways. Consul-General Robert P. Skinner, of Marseilles, states that Renard trains have been run from Paris to Marseilles over ordinary highways in order to supply the public with a demonstration of their efficiency. Each car receives the power necessary for its locomotion from the first vehicle or "locomotor" through a flexible transmission shaft, extending from one end of the train to the other, so that each car utilizes its own adhesion to the road surface as a means of advancement. Trains of this type, completely loaded, are able to maintain a speed of 13 miles per hour in the case of passenger trains, and 9 to 10 miles per hour in the case of freight trains, on a level road. It is also stated that freight trains of this type are able to maintain an average of from 6 to 7½ miles, fully loaded, in any kind of country. It should, however, be understood that the highways in Europe, in general, where these trains can be profitably used, are of a character that is only found in exceptional instances in the eastern part of the United States, and practically unknown all over the rest of the country. It seems possible that, in regions where railways would not prove profitable, this kind of transportation will have an important future ahead, but, of course, an extensive system of high grade, well-kept highways is a primary condition for its success.

FRICTION BRAKES.

H. D. James, in *The Electrical Journal*, May, 1908.

Although, at first thought, the brake may seem to be but a small detail in the construction of a crane, a hoist, or other device, a closer examination will show that it is a very important item, and one that may cause a great deal of trouble if improperly designed. The brake consumes mechanical energy in its friction surfaces and develops heat which must be radiated. Mr. H. D. James, and Mr. W. A. Paris, of the Westinghouse Electric & Mfg. Co., recently conducted a series of experiments extending over eighteen months to determine the best material to use for the friction surfaces in brakes. Endurance runs were made with cast iron shoes, and with shoes lined with wood, fiber, lignumvita, etc., on both cast iron and steel wheels. The best combination proved to be a cast iron shoe bearing on a cast iron wheel. Under heavy pressure the coefficient of friction was 0.3, and the wear on the brake wheel about one-sixteenth of the wear on the shoe. Cast iron shoes on cast iron wheels have been used for many years on freight cars and for street railway work, where the service is more severe and continuous than for most industrial applications. One advantage of using metal shoes bearing against a metal wheel is the increased radiating surface obtained. If an insulated lining is used, the heat from the rim of the wheel is not conducted directly to the brake shoe. This makes it necessary for the wheel to radiate most of the energy dissipated. Or, if a combustible lining is used, the permissible heating is limited, and a much larger brake wheel must be used to absorb a given amount of energy. These limiting conditions are obviated when a cast iron shoe is employed. Radiation may be improved by using a brake wheel ribbed on the inner side of the rim, and provided with fans for driving the heated air away from the motor bearings. The brake shoes should be provided with deep ribs to assist in radiation as well as to make them very stiff. Such a brake can be operated at a temperature which will turn cast iron to a blue color without in any way injuring the parts.

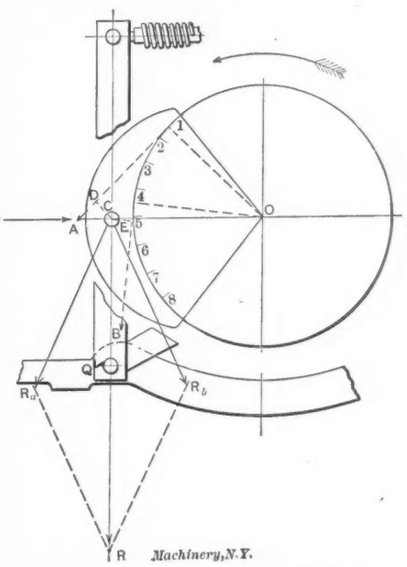
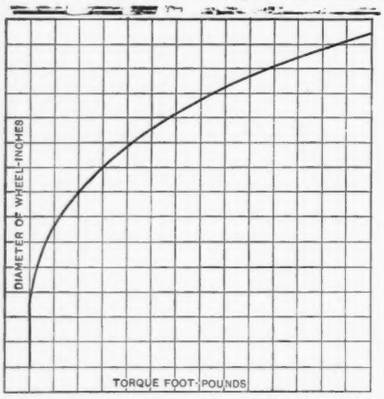


Fig. 1. Arrangement of Brake Rigging.

The usual method of suspending brake shoes causes them to exert an unequal pressure upon the brake wheel, because the resultant pressure produces a turning moment around the point of suspension, the shoes wear unequally, and the ends have a tendency to dig into the wheel when the brake is first applied, thus causing a severe strain on the motor shaft. This defect has been overcome by making the brake shoe stiff, so that the static pressure is uniform, and by selecting a point of suspension such as to eliminate the turning moment on the brake shoe. If the pressure is uniform and the surface of the shoe is considered as divided into a number of equal strips, the retarding force of each strip is the same, and may be considered as concentrated at the center of the strip, provided the number of strips is large. Selecting two strips, 1 and 4, Fig 1, the retarding force may be represented in amount and direction by the lines 1-*A* and 4-*B*, each at right angles with a line drawn from the center of the wheel to the center of the strip. Using a point of suspension, *C*, it may be seen that force 1-*A* tends to turn the shoe counter-clockwise around the point *C*, having a turning moment

equal to 1-A times CD, while the force 4-B, having a moment equal to 4-B times CE, tends to turn the shoe clockwise about point C. It is evident that point C may be so located that the sum of the moments for all the strips tending to produce counter-clockwise rotation is exactly balanced by the sum of the moments of those tending to produce clockwise rotation, and that the resultant pressure on the point of suspension due to the upper part of the shoe will be represented by a line such as R_a. In the same way the turning moments about point C for the lower part of the shoe will balance each other and produce a resultant pressure on C represented by a line R_b. The total resultant pressure of the shoe on the point of suspension C is represented by R, which acts directly along the hanger and through its pivot. There is, therefore, no tendency for the hanger to turn about its pivot, thus increasing or decreasing the pressure of the shoe as a whole against the wheel. If the point C is located in the manner described, it insures a uniform pressure per square inch on all parts of the brake surface, and freedom from any turning tendency about points C or the hanger pivot, and this is true for rotation in either direction. The results of this method of suspension are as follows:



Machinery, N.Y.

Fig. 2. Diagram showing Relation between Diameter of Wheel and Torque exerted by Brake.

a. The shoe is free to turn and find a true seat on the wheel.

b. The pressure of the shoe against the wheel is uniformly distributed.

c. The retarding force acts directly along the line of the brake hammer.

There is no tendency for the ends of the shoes to press harder against the wheel and thus wear away faster, and there is no tendency or possibility of one shoe pressing harder than the other, thus producing a side thrust on the shaft bearings. This insures an even wear on the shoe and wheel and long life for both.

The relation between the diameter of the wheel and the torque, exerted by the brake is expressed by the following formula:

$$D = 24\sqrt[3]{\frac{1}{144\,B\,C\,f\,p}} \times \sqrt[3]{\text{torque}}$$

where D equals diameter of wheel in inches; B equals angle (in radians) covered by two shoes; C equals width of wheel divided by the radius; f equals coefficient of friction; and p equals pressure in pounds per square inch.

By assuming fixed values for B, f and p, the curve shown in Fig. 2 was plotted. This shows that for small wheels the torque increases very slowly with the diameter of the wheel. As the size of the wheel approaches eighteen or twenty inches, the torque increases more rapidly than the size of the wheel, so that large brakes are more compact than small ones.

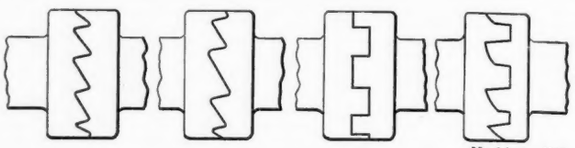
CLUTCHES.

Abstract of paper by Mr. Henry Souther before the Detroit Meeting of the American Society of Mechanical Engineers.

Clutches, in one form or another, have always constituted an important detail of machine construction. In general, however, engineers have not given clutches very great attention until recently, but now, when these devices have been called upon to do the delicate work required in connection with them in cotton mill machinery, printing presses, electric cranes, and automobiles, the real importance of clutch design has become apparent.

Positive Clutches.

The positive, or jaw clutch, is necessarily used only where a sudden starting action is immaterial, and where the inertia of the originally stationary or driven parts is relatively small. The different forms of positive clutches are modified merely in the angle of the engaging surfaces. The least positive form is one where the planes of engagement are inclined backward, as regards the direction of motion. The tendency of such a clutch is to disengage under load, and it must be held up to its work by axial pressure. This pressure may be regulated to perform normal duty, permitting the clutch to slip and disengage when overloaded. Positive clutches with the engaging planes parallel to the axis of rotation, must be held up to their work in order to prevent their natural tendency to jar out of engagement, but they present no safety features against overload. So called undercut clutches will engage tighter when loaded, and can be disengaged only when absolutely free from load, and in a condition permitting them to be rotated in a reverse direction sufficiently so that the undercut angular surfaces can clear each other. Some simple forms of positive clutches, embodying the fundamental principles, are shown in Figs. 1 to 4.



Machinery, N.Y.

Figs. 1 to 4. Examples of Positive Clutches.

Friction Clutches.

While there is an infinite variety of detail in construction and manipulation of friction clutches, they might all be classified as belonging to one of the following four types: contracting band friction clutches, friction cone clutches, friction sector clutches, and friction disk clutches.

The most simple form of clutch is, perhaps, the Ramsbottom clutch, used for rolling mill work. It is, in reality, a friction coupling in which one flange is squeezed in between two other flanges, tightly bolted together. This clutch is shown in Fig. 5. The flange A is firmly clamped between the wood-lined surfaces of B, the bolts clamping these parts together, so that the friction will resist normal torque, but yield to abnormal torque.

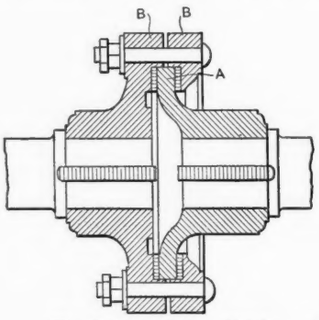
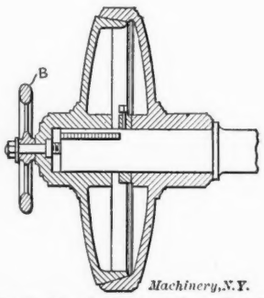


Fig. 5. Ramsbottom Clutch.



Machinery, N.Y.

Fig. 6. Simple Form of Cone Clutch.

In Fig. 6 is shown the simplest form of cone coupling, where the two parts are being forced into engagement by a screw and a hand-wheel B. The angle of the cone should not be less than 10 degrees. The coefficient of friction for two iron surfaces in a clutch of this character is about 0.15. The mean radius of the cone should be kept within 3 to 6 times the diameter of the shaft, in order to keep the axial pressure within reasonable limits.

A further development of the friction cone clutch is shown in Fig. 7. This clutch may be termed the multi-cone friction clutch, being provided, as it is, with a series of concentric cone-shaped rings, of 20 degrees included angle. The design shown in the engraving requires that the collar on the shaft and the yoke in the engaging sleeve resist the pressure due to the axial pressure necessary for proper engagement, which causes serious wear. Such wear, however, is avoided in heavy or high speed machines by making the axial pressure

self-contained on the rotating members. A modification intended for this purpose is shown in Fig. 8. The pressure required for engaging the two clutch halves *A* and *B* is obtained by tightening hand-wheel *C*, the thrust being taken by collars on the respective shafts in such a manner that the ends of the shafts are forced together.

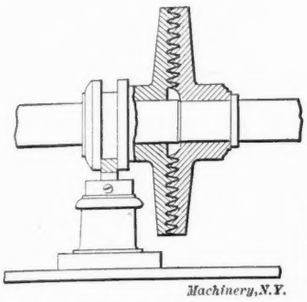


Fig. 7. Multi-cone Clutch of Objectionable Design for Heavy Work.

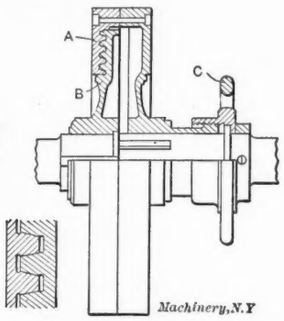


Fig. 8. Principle of Self-contained Multi-cone Clutch.

Another fundamental type of clutch is shown in Fig. 9. This is of the internal expanding type, three internal clamping pieces *A*, fitted with bronze shoes, being thrust out against the enclosing cylindrical drum *B*, by means of lever and screw action. There is no danger of wedging in this clutch, as exists in connection with the cone clutch.

In Fig. 10 is shown the well-known Weston clutch, which is based on the fourth fundamental principle mentioned above, that of multiple plate friction. The plates are alternately wood and iron, the wooden ones engaging with the outside cylindrical case *A*, and the iron ones with the shaft *B*. In the form shown, the plates are pressed together by springs *D* and disengaged by drawing back a collar-sleeve *C*, which releases the spring pressure.

Machine Shop Clutches.

The clutches shown so far have been intended simply to indicate basic types. The following examples will illustrate

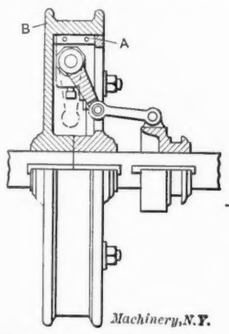


Fig. 9. Internal Expanding Type of Clutch.

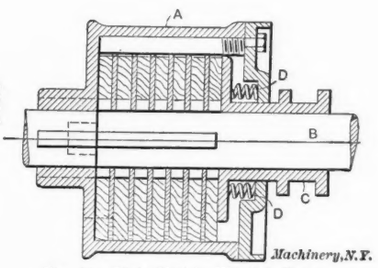


Fig. 10. Disk Clutch, Weston Type.

the development of present practical machine shop clutches. The simplest type is one in which one flat disk presses against another, the surfaces being either leather against iron, bronze against iron, or wood against iron. Such a type is shown in Fig. 11. The wooden disk *A*, attached to the casing *B*, is gripped between two iron surfaces *C*, keyed to the driving shaft. In order to prevent a drag when disengaged, separating springs *D* are placed between the iron disks. An interesting clutch, formerly known as the Frisby clutch, was designed many years ago. This clutch is shown in Fig. 12, and in this one flat surface *A* and the cone surface *B* are used in combination. The gripping of the surfaces is accomplished in a manner similar to that of the clutch in Fig. 11. It is apparent that this clutch would require less axial pressure for any given horse-power transmitted than the foregoing type, because of the cone; or, in other words, for a given axial pressure it would transmit more power and therefore would be smaller and more compact, all other things being equal. But here we meet with the uncertainty of the coefficient of friction. This clutch, for example, might throw its oil to the frictional surfaces more than the previous example, which oil would more than offset the effect of the cone engagement.

Very little information is obtainable in regard to the frictional capacity of this class of clutches and the knowledge at hand is of an empirical character. The Dodge Manufacturing Co., Mishawaka, Ind., gives some experimental data on the capacity of this class of clutches. The results are obtained from clutches fitted with maple blocks, and calculations are based on a coefficient of friction of 0.37 and a speed of 100 R.P.M.

TABLE OF HORSE-POWER TRANSMITTED BY FRICTION CLUTCHES.

Horse-power.	Block Area.	Diameter at Block, inches.	Circumferential Pull at Block Center.	Total Pressure.	Total Pressure per sq. in.
25	120	16	1960	5300	44
32	141	18	2240	6000	44½
50	208	21½	2900	7800	37½
98	280	27½	4500	12200	43½

A modern development of the expanding ring clutch is shown in Fig. 13. These clutches are largely used for heavy work and are made by the A. & F. Brown Co., Elizabethport, N. J., in sizes up to 48 inches in diameter, capable of transmitting 320 H.P., at 100 R.P.M. The frictional surfaces are of wood, especially prepared for the purpose, the casing being of iron.

One of the oldest usages made of clutches is in wire drawing manufacture. The iron drum, around which the wire is wrapped, as a rule contains some form of clutch within it. A recent development of this class of clutch is shown in Fig. 14, being a clutch made by the Morgan Construction Co., Worcester, Mass. This clutch is working on the compound principle, the main driving effort being furnished by a wrapping coil on a chilled iron surface, the initial engagement of the coil being brought about by a modified cone or ring, slipping down onto a cone which drags the free end of the coil into engagement. When once seized, the wrapping continues until tight. In Fig. 14, *A* is the tapered friction surface of the chilled drum on which the friction ring bears, and below this is the coil, which is submerged in oil in an annular oil chamber. The drum is 12 inches in diameter by 7 inches high, and the coil, made of soft steel, is 1½ inch square at the large end and ⅜ by ⅝ inch at the small end.

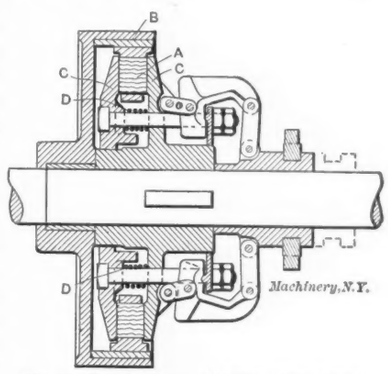


Fig. 11. Simple Form of Single Disk Clutch.

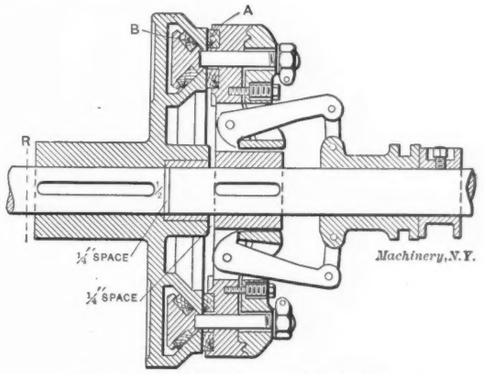


Fig. 12. Combined Cone and Disk Clutch.

A strong demand has developed for clutches of small dimensions for a given capacity. This demand has been met by resorting to hardened tool steel frictional parts, as this permits exceedingly high normal pressures between the frictional surfaces. Fig. 15 shows such a clutch, known as the Johnson friction clutch, made by the Carlyle-Johnson Machine Co., Hartford, Conn. The operating sleeve *A* forces wedge *E*

between the two long arms of the levers *C*, thereby spreading them in such a manner that they expand the friction ring *D* against the hardened drum *E*, enclosing the friction ring. This enclosing ring is an integral part of, or connected with, the driven pulley or shaft. As much as 100 H.P. has been transmitted, at 1,000 R.P.M., with a clutch of this type, having friction rings 5¼ inches in diameter and 1½ inch wide.

Clutches with Cork Inserts in the Frictional Surfaces.

Commercial clutches of the form now discussed have recently been designed with cork friction surfaces, with considerable success. Cork has a high coefficient of friction, probably double that of wood or leather on iron. As a rule the cork is forced into suitable cavities formed in one of the

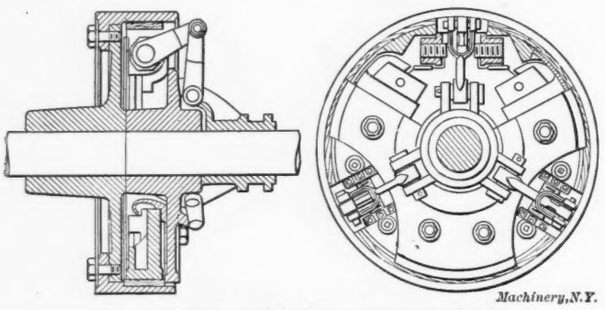


Fig. 13. Modern Application of Expanding Clutch.

metallic frictional surfaces. The cork is previously boiled, and thereby softened, before being pressed into the cavities. When so inserted in a metal surface, it normally protrudes above the surrounding surface, and engages first when the surfaces are brought together. If sufficient pressure is applied to the clutch, the cork is forced down flush with the metal surface and acts with it in carrying the load. When the clutch is released, the cork will again protrude beyond the surrounding metal surface.

Two forms of cork are used, one being the cork in its natural condition, the other prepared as follows: Small pieces are compressed into sheets and blocks of any desired shape under very great pressure and under enough heat to cause the natural gums of the cork to exude and act as a binder. This form of prepared cork is really more enduring than the natural, being stronger, firmer and yet possessing much elasticity, but it is expensive and has not had wide use for this reason. Nevertheless, it has been most successful in performing service beyond the capacity of other materials.

As an example of this, it may be mentioned that a Dodge friction clutch carrying 500 H.P. gave much trouble on account of being overloaded. This clutch was strained up as tight as possible, and it was all a man could do to throw it. The maple blocks used were replaced with compressed cork. It was then possible to loosen the adjustment of the clutch to such an extent that the operator could throw it with little effort. Following this change it was found that a set of cork blocks outlasted the maple ones five to one.

COMPARATIVE TESTS OF LOOM CLUTCHES.

Average results of eight positions.
Torque measured in pounds-feet.

Pressure on Clutch, pounds.	Torque.	
	"Compo" Clutch with Cork Inserts.	Leather-faced Clutch.
89.5	19.50	16.95
151.5	34.20	17.66
213.0	46.43	23.09
275.0	57.05	29.46
337.0	73.33	36.09
398.0	82.24	41.31
460.0	96.48	47.56

Prof. I. N. Hollis of Harvard University has determined the coefficient of friction of cork on metal. He found that the coefficient of friction for plain cast iron on cast iron is about 0.16; similarly, for plain bronze on cast iron the coefficient of friction is 0.14. The coefficient of friction of the cork on the cast iron, however, was found to be from 0.33 to 0.37, the former, 0.33, being the value for the heavier loads.

It is apparent that the coefficient of cork on iron or steel is about double that of iron on iron. It is further claimed that the coefficient of friction is not very much less when the cork is lubricated. Cork has much advantage in a moist atmosphere, being very slightly affected by moisture, as compared with maple blocks ordinarily used.

Tests have been made by Prof. C. M. Allen of the Worcester Polytechnic Institute in connection with loom clutches, showing that for a given dimension of clutch the torque for cork inserts is nearly double that of a leather-faced clutch.

Automobile Clutches.

The latest development in clutches has been due to the development of the automobile. In clutches for this purpose, the matter of absolute disengagement is perhaps the most important. An important feature in the clutch is also the question of its weight, especially as affecting its inertia. A clutch having high fly-wheel effect spins to such an extent as to cause violent clashing of idle gears. Consequently, clutches are made as light as possible, and the smaller in diameter the better. Aluminum enters largely into clutch construction for this reason.

One of the simplest forms of clutch, which is commonly used for small machines, and in connection with the planetary system of change gearing, has one disk covered with leather, bronze, or copper, and is pressed against another of iron or steel. The engagement of this clutch is soft and gradual, but it is open to the objection that a small amount of oil coming in between the surfaces renders it absolutely useless. Such a clutch, when reasonably dry, will drive a car up a grade

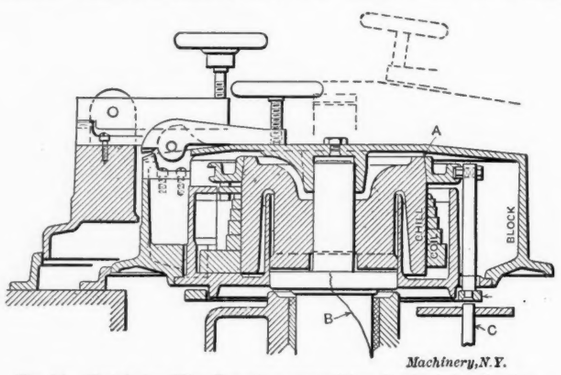


Fig. 14. Clutch for Wire Drawing, permitting Gradual Application.

sufficient to stall the engine. The same clutch, with too much oil between the friction surfaces, will not drive a car up a half per cent grade on asphalt. This is a good illustration of the uncertainty in clutch design, as far as frictional capacity is concerned.

For automobile clutches, all things considered, the best form when properly designed and mounted is the cone clutch. It has the advantage of engaging and disengaging with very small axial motion. The axial pressure may be low, because the normal pressure between frictional surfaces is multiplied by the angularity of the cone. This clutch may also be small, and the disengagement may be made perfect. Proper engagement, however, has proved to be a very difficult problem, and the cone clutch must therefore be absolutely free to center itself and seat itself uniformly.

Leather riveted onto an aluminum cone usually forms one of the rubbing surfaces and gray cast iron the other. It is desirable that the leather shall be kept soft by neatsfoot or castor oil. Some builders boil the leather in tallow before applying to the clutch surface; others do not, but this matter is of minor importance. With leather ¼ inch to ⅜ inch thick, properly softened, engagement may be sufficiently mild, but an improvement is obtained by placing under the leather at six or eight points on the periphery of the cone, flat or spiral springs that cause the leather to engage at these points a little bit before engaging elsewhere.

It is obvious that the construction surrounding the clutch must be such that, by no means, can an unusual supply of

lubricant find its way to the frictional surfaces of the clutch. With proper usage, cone clutches with leather faces seem to last indefinitely.

There has been a considerable variety of opinion as to the proper cone angle. Various authorities have placed it all the way from 7 degrees to 20 degrees. The French have settled down on an 8-degree to 9-degree angle as being about right

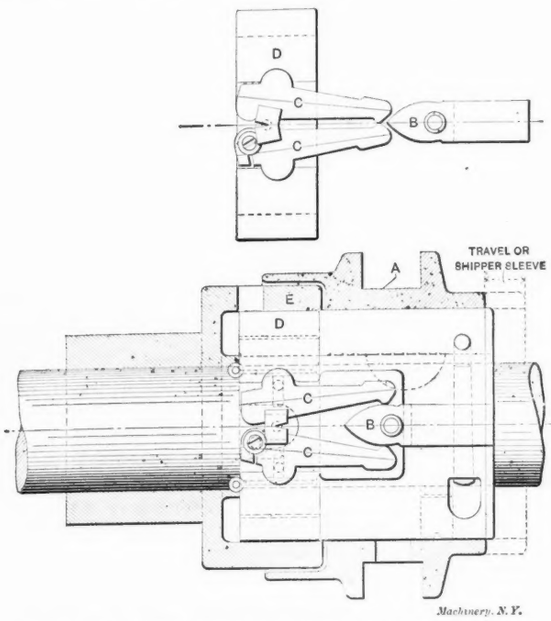


Fig. 15. The Johnson Clutch, used largely on Machine Tools and on Counter-shafts.

for a leather-faced cone. Several important American makers are using 12 degrees to 13 degrees, several 10 degrees, and others 8 degrees.

In general, these clutches present no difference in design from the types already illustrated. Some clutches have been brought out, however, of rather novel construction. An interesting form is shown in Fig. 16. This may be called a multi-cone clutch. When the clutch engages, the smallest cone seizes first and commences to revolve, and subjects thereby the spiral spring between the next two clutches to a torsional movement, which draws the springs together and brings the two outside clutches into action. The principle of the clutch is that the small clutch shall slip when the car starts and that the medium clutch shall behave in a similar manner when engaged, and that finally, the large clutch, when it

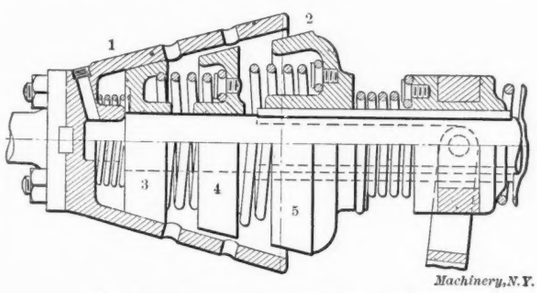


Fig. 16. Multi-cone Clutch of Novel Design.

comes into play, shall present sufficient frictional resistance to take up the full load in combination with the other clutches. It does not appear that this clutch has been tried out sufficiently to say whether it is a practical success, but the idea is a rather ingenious one.

Theory has not entered largely in clutch design, but in Fig. 17 is shown a simple clutch embodying the tractrix curve. This curve is adopted, because it is of such a form that by the calculated relation of pressures and peripheral speed, the wear ought to take place uniformly at all points, regardless of the distance of the point from the center. On account of this it is claimed that the clearance required is very small; that there is no wedging action between the two members of the clutch; and that there is no chance for it to bind.

A simple formula for calculating the ordinary cone clutch is the following:

$$\text{H.P.} = \frac{PfrR}{63{,}000 \sin \theta}$$

P = assumed pressure of engaging spring in pounds,
f = coefficient of friction, which in ordinary practice is about 0.25,
r = mean radius of the cone in inches,
R = revolutions of the motor per minute,
$\sin \theta$ = sine of the angle of the clutch.

To obtain the size of spring when the horse-power is known, the following formula may be used with good results:

$$P = \frac{\text{H.P. } 63{,}000 \sin \theta}{frR}$$

the same symbols being used as in the preceding formula. It will be noted that the coefficient of friction used is 0.25. This is probably near enough for a properly lubricated leather-iron clutch.

Expanding and contracting band clutches are used to some extent in automobile construction. The principle involved in all these is that a friction ring with sufficient flexibility either expands on the inside of a drum, or casing, or contracts on the outside of a drum, transmitting power by the friction between the expanding or contracting band and the drum. The mechanical designs to accomplish this have been greatly varied, but the designs are rather complicated. Clutches of this type are not greatly in favor in successful automobile designs.

Disk clutches on the other hand, are widely used. The principle involved in these clutches is a simple one, and has already been referred to in connection with our general classification of clutches. Cork inserts may be used in these clutches to considerable advantage. The question of lubrication is very important in these clutches, and in fact, it would seem that the principal problem in connection with the multi-disk clutch in particular is proper lubrication.

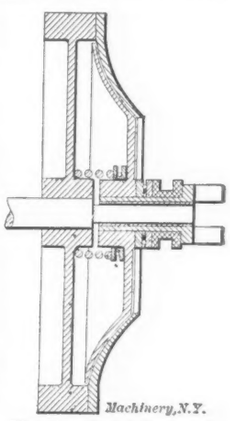


Fig. 17. Clutch Designed for Uniform Wear.

A modification of the multi-disk clutch, in which the cone and the disk are combined, is attracting much attention. This clutch is known as the Hele-Shaw clutch and has previously been described in these columns (see MACHINERY, October, 1903, engineering edition, and May, 1908, engineering and shop edition). With this clutch, 1,000 H.P. is being transmitted at 700 or 800 R.P.M., the clutch being 18 inches in diameter. The following table gives the dimensions and number of plates used for clutches transmitting different H.P.

	Bronze.	Steel.
25 H.P., 27 plates of 6½ in.....	14 outer	13 inner
40 H.P., 25 plates of 8½ in.....	13 outer	12 inner
60 H.P., 21 plates of 11 in.....	11 outer	10 inner

Pneumatic clutches have been developed, but have not been widely used, because of their cost. In these a plain, leather-faced disk is pressed against a metal plate. The air deflects the leather, and causes it to bear against the metal disk, which is given a slight, endwise motion. Hydraulic clutches have also been used, but are not very popular.

Magnetic clutches are in use and are fairly successful. One complication in magnetic clutches arises in the fact that one of the parts of the magnet must rotate continuously, the gears being always in mesh; consequently the exciting current must be carried to it by a brush. These clutches usually seize rather abruptly unless carefully controlled. A considerable current is also necessary on the car for the operation of the clutch. These complications rather interfere with its extended usage.

DIMENSIONS OF SCREW HEADS AND NUTS.

A great many attempts have been made to standardize the dimensions of screw heads and nuts, but none so far has been undertaken under the auspices of any sufficiently recognized agency to command, for the particular standard in question, universal recognition. Strictly speaking, therefore, there are no standard dimensions for screw heads or nuts. The most prominent firms in this country, however, have adopted for their own use standards which do not materially differ from one another. In the following, dimensions are given for a number of different types of screw heads and nuts, these dimensions agreeing, in most particulars, with those in use at the Pratt & Whitney Co., Hartford, Conn.

In the tables in the Supplement, giving the sizes, no dimension has been given for the length of the screw itself, nor for the length of the thread, because these dimensions depend, of course, entirely upon the conditions for which the screws are to be used. In order to give a convenient rule to follow, however, for the length of the thread, it may be said that the length of the thread should equal two times its diameter, whenever the total length of the screw below the head is more than two times the diameter. When the total length of the screw is less than two times the diameter, the screw is threaded practically all the way up to the head.

In Table I in the Supplement, dimensions for the heads of screws with fillister heads are given. Two styles are shown; in the one it will be noted that the upper end of the head is rounded, whereas in the other the corner is sharp. The one kind of head is used when the screw head is permitted to project slightly above the surface of the work, which is common, particularly when the surface of the work is not finished. The other style shown, having a sharp corner at the upper edge, is intended for use where the screw comes flush with the surface of the work, which, in this case, always is finished. All dimensions for both types of heads are the same, excepting those which are influenced by the slight rounding of the corner. Dimensions are given for the width and depth of the slot for the screw-driver. It will be noticed that in order to prevent getting too many different widths of slots, several sizes are provided with the same dimensions for the slot.

In cases where the screw heads are not standard, it is a good rule to make the width of the slot according to the formula

$$W = 0.135 \times D,$$

where W = width of slot for screw-driver, and
D = diameter of bolt or screw.

A mistake which is often committed is to make the screw slot in proportion to the diameter of the head, irrespective of the diameter of the screw. This, however, is not correct, and often results in screws being twisted off by too large a screw-driver inserted in the slot in a special large head, the slot being proportioned according to the head, and not according to the screw to be tightened. While this would have no reference to screws with standard heads, it may not be out of place to mention it in this connection.

In Table II in the Supplement are given dimensions for the heads of standard square head screws. These screws are most commonly provided with a flat point as shown in the upper view, the screws being used for binding or set-screws; but not infrequently these binding screws are made with an angular point, as shown in the lower right-hand view in Table II, the included angle of the point being 90 degrees. At the left is shown still another form of point frequently used.

In Table III dimensions are given for headless set-screws. The dimension D is for the slight round at the upper end of the screw. Of course, the dimensions given in this case refer practically only to the size of the slot for the screw-driver. Three different types are indicated, one having a flat point and the two others being pointed, one to a 120-degree included angle, and the other to a 90-degree included angle.

In Table IV is shown a kind of screw known as a collar-head screw, having a square head and circular collar, which latter binds up against a surface of the work. These are commonly made with different sized heads for the same size bolt, in order to permit different sized bolts to be used, all of which would have the same size head, so that the same wrench may be employed for the different screws. These screws are usually threaded as near to the shoulder as possible, when the total length below the shoulder or collar is one inch or less; for screws longer than one inch, and up to 1½ inch, one inch length of thread is sufficient. For longer screws five-eighths of the length under the shoulder is usually threaded.

In Table V standard hexagon head screws are shown and dimensioned. These are used, as a rule, only in sizes larger than ¾ inch, the smaller sizes of screws for similar purpose being of the collar-head type. In the former, when the length under the head is longer than two times the diameter of the bolt, the length of the threaded portion should equal two times the diameter.

In Table VI dimensions are given for regular hexagon nuts, and in Table VII for hexagon nuts having less than the standard number of threads per inch, in this case 16 threads. These nuts, of course, can be made considerably thinner than the standard nuts. The thickness of these nuts is purely arbitrary, and there is no really good reason why a ¾ nut, for instance, should be only 5/16 inch thick, and a 2-inch nut 5/8 inch thick, if both are provided with 16 threads per inch. The figures given, however, embody common practice. In Table VIII are given dimensions for hexagon check nuts with regular standard threads. These check nuts are rounded on both sides, and are considerably thinner than the standard nut.

In Table IX dimensions are given for washers used in connection with standard bolts and nuts. It will be noted, upon examination of the table, that these are proportioned according to certain definite rules, and these rules are embodied in the following formulas:

$B = 2A + \frac{1}{8}$ inch, for A less than one inch,
$B = 2A$, for A equal to one inch or over.

$$C = \frac{A}{4} + 1/32, \text{ for } A \text{ less than one inch.}$$

$$C = \frac{A}{4}, \text{ for } A \text{ equal to one inch or over.}$$

In these formulas
A = hole through washer,
B = diameter of washer, and
C = thickness of washer.

While the nominal size of the hole through the washer is A, the hole should be made from 0.002 to 0.005 inch larger than the nominal sizes of the bolt for which they are intended.

Square heads for bolts intended for standard T-slots should be made to dimensions given in Table X. This table also gives the dimensions of the T-slots, in accordance with the dimensions of standard T-slot cutters, as manufactured by the Pratt & Whitney Company and the Brown & Sharpe Mfg. Co. The dimensions for nuts used in standard T-slots are given in Table XI.

* * *

A convenient rule for calculating the weight of cold-rolled shafting has been expressed in formula by Mr. H. E. Roush, Marion, Ohio, as follows: Weight per foot $= \frac{(\text{diameter} \times 4)^2}{6}$, or $\frac{8\ d^2}{3}$, in which d is the diameter, in inches. For example, the weight of a 3-inch shaft is $\frac{8 \times 3 \times 3}{3} = 24$ pounds. A rule of some value in certain cases for calculating the weight of steel plates is: The continued product of the length (in feet), the breadth (in inches), the thickness (in inches) and 3.4 is the weight in pounds. For example, what is the weight of a steel plate 5 feet long, 40 inches wide and ¾ inch thick? $5 \times 40 \times \frac{3}{4} \times 3.4 = 510$ pounds, answer. In both cases the weight of rolled steel is assumed to be 489.6 pounds per cubic foot, which agrees closely with standard authorities.

HOW TO OBTAIN APPROXIMATE FRACTIONS BY THE METHOD OF CONTINUED FRACTIONS.

MITCHELL DAWES.*

Mitchell Dawes.†

Having exceptional opportunities for observation, I think it would not be untruthful to say that not more than 2 per cent of the men hired as being capable machinists and operatives on general work, understand the subject of continued fractions well enough to use them in obtaining approximate fractions. And having been repeatedly requested to put the subject in such shape that the ordinary man might understand it, I send herewith an article which I trust will be helpful to that extent.

In a work published by the Brown & Sharpe Mfg. Co., entitled "Practical Treatise on Gearing," the subject of continued fractions is taken up and explained in detail, and yet many machinists and apprenticed machinists are not well enough posted in mathematics to apply these rules in their regular shop practice. The reason for my sending this article is more for their enlightenment than any other purpose.

Now, I do not propose to enter into an explanation of what continued fractions are, as that is fully explained in the treatise above mentioned. When we have a fraction that cannot be factored and we resolve it into other fractions by the process of continued fractions, these fractions are called approximate fractions.

An Example for Illustration.

As an illustration, I will work out an example and show each successive step in its solution. If the reader will follow this explanation and apply it to like problems that he desires to solve, I think he will have very little trouble in obtaining satisfactory results in the future. Suppose, for example, that it is required to cut a spiral worm by means of a B. & S. milling machine, and the lead of said worm is to be 7.29 inches; find the necessary gears.

The required lead being 7.29 inches, then expressed as a fraction, it will read $\frac{7.29}{10}$ (the 10 being the ratio between the spiral head spindle and the table feed-screw of the milling machine, when the driving and driven gears are alike). For every decimal place in the numerator, add one cipher to the denominator and remove the decimal point from the numerator, thus making it a common fraction; it will then read $\frac{729}{1000}$. Reduce this fraction by the process of "continued fractions as follows:

$\frac{729}{1000}$

729)1000(1
729
271)729(2
542
187)271(1
187
84)187(2
168
19)84(4
76
8)19(2
16
3)8(2
6
2)3(1
2
1)2(2
2
0

(In solving this example, it will be noticed that each divisor is divided in its turn by the last remainder.)

Now take the several partial quotients and arrange them in a line,

$+ - + - + - + - 0$

thus: 1 2 1 2 4 2 2 1 2. Starting with the first one on the left, we call it plus (+) because when formed into its fraction it will be more than the original fraction $\frac{729}{1000}$ and the second will be minus (—) because it will be less than the $\frac{729}{1000}$ and so on, alternately plus and minus, each successive fraction being a little nearer the exact fraction $\frac{729}{1000}$ as it approaches the last one which is 0, or the fraction itself.

The Approximate Fractions.

To obtain the first fraction:

Take (1) the first partial quotient for a denominator and 1 or unity for its numerator, thus $\frac{1}{1}$. In relation to this first partial quotient and its connection with the first approximate fraction, I would state that no matter what the first partial quotient was found to be, say 1 or 5 or 7 or 10, in *all* cases it is taken for the first denominator, and 1 placed over it for a numerator, making it $\frac{1}{1}$ or $\frac{1}{5}$ or $\frac{1}{7}$ or $\frac{1}{10}$ as the case might be.

To obtain the second fraction:

Multiply (1) the numerator of the first fraction by (2) the second partial quotient, thus $2 \times 1 = 2$, which is the numerator of the second fraction, then multiply (1) the denominator of the first fraction by (2) the second partial quotient, thus $2 \times 1 = 2$, and to this product add (1) the numerator of the first fraction, thus $2 \times 1 + 1 = 3$, the result being the denominator of the second fraction; complete, it is $\frac{2}{3}$.

To obtain the third fraction:

Multiply (2) the numerator of the second fraction by (1) the third partial quotient and to the product add (1) the numerator of first fraction. Thus $2 \times 1 + 1 = 3$, which will be its numerator; then multiply (3) the denominator of the second fraction by (1) the third partial quotient and to the product add (1) the denominator of first fraction, thus $3 \times 1 + 1 = 4$, which will be its denominator; complete, it is $\frac{3}{4}$.

To obtain the fourth fraction:

Multiply (3) the third numerator by (2) the fourth partial quotient and to the product add (2) the second numerator, thus $3 \times 2 + 2 = 8$, which will be its numerator; then multiply (4) the denominator of the third fraction by (2) the fourth partial quotient and to product add (3) the second denominator, thus $4 \times 2 + 3 = 11$, which will be its denominator; complete, it is $\frac{8}{11}$.

The remaining fractions are found, as were the third and fourth, thus:

To obtain the fifth fraction $8 \times 4 + 3 = 35$, its numerator, and $11 \times 4 + 4 = 48$, its denominator.

To obtain the sixth fraction $35 \times 2 + 8 = 78$, its numerator, and $48 \times 2 + 11 = 107$, its denominator.

---

* Address: Brown & Sharpe Mfg. Co., Providence, R. I.

† Mitchell Dawes was born in Saugerties, Ulster County, N. Y., and was educated at the Saugerties Academy. He served an apprenticeship with the Brown & Sharpe Mfg. Co., Providence, R. I., and has worked for Laflin & Rand Powder Co., Hendrie Bros. & Holthoff, Union Paper Box Co. and Sheffield Paper Co. He was appointed instructor of apprentices of Brown & Sharpe Mfg. Co., January, 1897, which position he still holds. Mr. Dawes' specialty is apprenticeship instruction. He has delivered addresses on apprenticeship system before the New England Association of Teachers of Metal Work and to the students of the Rhode Island College of Agriculture and Mechanic Arts. Since he has had charge of the apprentices at Brown & Sharpe Mfg. Co., two hundred and forty-five have completed their apprenticeship course and one hundred and twenty-five are still under instruction.

To obtain the seventh fraction $78 \times 2 + 35 = 191$, its numerator, and $107 \times 2 + 48 = 262$, its denominator.

To obtain the eighth fraction $191 \times 1 + 78 = 269$, its numerator, and $262 \times 1 + 107 = 369$, its denominator.

To obtain the ninth and last fraction $269 \times 2 + 191 = 729$, its numerator, and $369 \times 2 + 262 = 1000$, its denominator.

The following are the approximate fractions as they have worked out in this example:

$$\begin{array}{cccccccccc} 1 & 2 & 1 & 2 & 4 & 2 & 2 & 1 & 2 & = \text{partial quotients.} \\ + & - & + & - & + & - & + & - & 0 & \\ \hline 1 & 2 & 3 & 8 & 35 & 78 & 191 & 269 & 729 & \\ \hline 1 & 3 & 4 & 11 & 48 & 107 & 262 & 369 & 1000 & = \text{the approximate fractions.} \end{array}$$

After the first and second approximate fractions have been found, the remaining fractions can be obtained by working according to the following rule. Multiply the numerator of the last fraction found, by the next partial quotient, and to this product add the numerator of the preceding fraction; the sum will be the numerator for the next fraction. Take a similar course for the denominator, that is, multiply the denominator of the last fraction found, by the same partial quotient as was used to obtain the numerator just found and to this product add the denominator of the preceding fraction; the sum will be the denominator for the uncompleted fraction. Continue in this manner until all the partial quotients have been used, and fractions obtained. The last fraction will be the original fraction, or a fraction of equal value. In this case, it is 729/1000.

The fraction 35/48 derived from the fifth partial quotient in the continued fractions, has been selected as the one which can best be used, and being factored and raised to higher terms, thus:

$$\frac{35}{48} = \frac{7 \times 5}{6 \times 8} = \frac{56 \times 40}{48 \times 64} = \text{the gears chosen.}$$

Proof: $56 \times 40 \times 10 \div 48 \times 64 = 7.2916 +$ inches, an error of 0.0016 inch, which is near enough for all practical purposes.

Proving an Approximation.

By continued fractions you may be in doubt whether or not a chosen approximate fraction will be near enough to the required one to allow its use. Then prove it.

Example:

Suppose you should desire to cut a screw of 2.243 turns per inch, and being unable to factor it, you obtain approximate fractions, thus:

```
243)1000(4
    972
    ---
  28)243(8
     224
     ---
   19)28(1
      19
      --
    9)19(2
      18
      --
     1)9(9
       9
       -
       0
```

$$\begin{array}{cccccc} + & - & + & - & & 0 \\ 4 & 8 & 1 & 2 & & 9 \\ 1 & 8 & 9 & 26 & & 243 \\ \hline 4 & 33 & 37 & 107 & & 1000 \end{array}$$

Selecting 9/37 you decide to cut 2.9/37 turns per inch, instead of 2.243/1000 turns per inch. Then to find how near this selected fraction is to what was first wanted, you reduce it to thirty-sevenths, thus, $2.9/37 = 83/37$ and dividing the numerator by the denominator, the quotient will show how near this selected approximate fraction is to the required thread, thus:

$$83 \div 37 = 2.243243 +$$

What we obtain by this selection is....	2.243243
What we wanted was.....	2.243000
	0.000243

This error is so slight that for all practical purposes it may be used.

Supposing your lathe has a lead of 4 turns per inch, your ratio would be thus expressed: $\frac{4}{\frac{83}{37}}$. Reducing the lead of the lathe to the same terms (*viz.*, thirty-sevenths) you obtain $\frac{148}{37}$,

then $\frac{\frac{148}{37}}{\frac{83}{37}} = \frac{148}{83}$ which being factored equals

$$\frac{74 \times 2}{83 \times 1} = \frac{74 \times 70}{83 \times 35} = \begin{array}{l} \text{Drivers.} \\ \text{Driven.} \end{array}$$

General Proof.

Product of driven gears by lead of lathe, thus, $83 \times 35 \times 4 = 11620$.

Product of driving gears $74 \times 70 = 5180$, and $11620. \div 5180 = 2.243243 +$ or the turns per inch this combination will cut.

It will be noticed that one example is for the lead, while the other is for the turns per inch.

No doubt some of your readers will say that this article is entirely too elementary, and enters too much into detail. Should that be the case, my reply would be that it was written for those who needed just such details.

* * *

MACHINE SHOP PRACTICE.*

RE-PLANING A LOCOMOTIVE DRIVING-BOX.

When a locomotive is being repaired, particular attention should be given to the driving-boxes, for if this part of the work is slighted and the boxes overhauled improperly, the result will be manifest, after the engine goes into service, in the shape of pounds which are difficult to overcome. As is well known, each driving-box is held in its place by a shoe and wedge which are fitted to the jaws of the locomotive frame. The usual construction is to have one of these jaws tapering, as shown in the illustration, Fig. 1, with a corresponding taper on the back of the wedge so that as the wedge is raised or lowered the distance between the faces of the shoe and wedge can be varied. When the box is in its place, the wedge is adjusted until the box is just free enough so that it can be moved up and down, for when the engine is in motion there is more or less of this vertical movement which would be impossible if the wedge were set up too tightly. This continual movement of the box results in more or less wear on its shoe and wedge bearing faces, and, consequently, it finally becomes necessary to replane these faces in order that the boxes may have a free movement with a minimum amount of lost motion.

When the brasses are considerably worn and need to be renewed, the new ones should be put in the boxes and bored before the shoe and wedge bearing faces are planed. The brasses are usually forced into place under considerable pressure, the ultimate pressure ranging from 10 to 18 or 20 tons, depending upon the sizes of the boxes, and the result is that the bottoms of the boxes generally spread apart, sometimes as much as 1/16 inch. Obviously, if the shoe and wedge faces of the box had been planed previously, the insertion of a new brass would render them unparallel. The boring of the brass for the journal should also be done prior to the planing operation, as the removal of the metal when boring has a tendency to cause the sides of the box to spring inward or toward its original shape. The dotted lines *A* in Fig. 1 show in an exaggerated manner the shape of a box planed prior to boring. It will be seen that if the faces of the shoe *B* and wedge *C* are parallel with each other, the bearing between them and the box will be at the top, leaving the bottom of the box free to move back and forth. This lost motion will result in a pound when the engine is in service, and this will increase as the springs weaken, causing the frame with the shoe and wedge to lower. Trouble of this kind, however, is not always

* With Shop Operation Sheet Supplement.

due to improperly planed boxes, for, as the brass wears, the sides of the box tend to close in, especially if equipped with poorly-fitting cellars.

When a locomotive is to be equipped with a new set of boxes, it is the usual practice to do the planing work on all of them at the same time, which is, of course, the most economical way. When re-planing, however, it is often impracticable to plane more than one or two boxes at a time because of variations in their size, unless it is desired that there be no such variations. Of course a set of boxes of different sizes might be lined up to prevent removing too much metal from the larger ones, but this would require considerable time, and

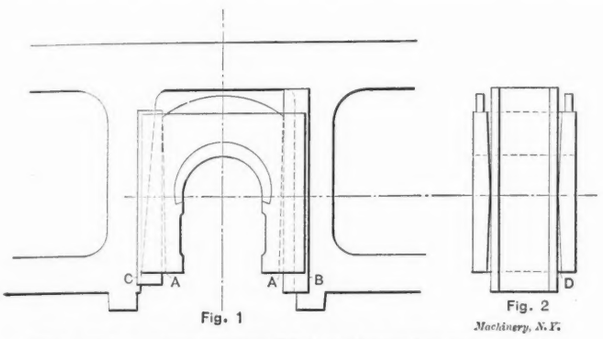


Fig. 1 Fig. 2

Machinery, N.Y.

Figs. 1 and 2. Views showing Effect of planing Box prior to Boring, and Box with Tapered Flanges.

it is doubtful if the work could be accomplished as quickly in this way as when planing the boxes in pairs, taking care to select those most evenly matched.

In Shop Operation Sheet No. 70, accompanying this issue, the method of laying out a box preparatory to planing has been described. It is the common practice on railways to bore the brasses of all boxes central with the shoe and wedge bearing faces. Therefore, when planing these faces, the boxes are laid out from the bore or, from what is practically the same thing, the surfaces t and u. The points J and K should be located so that the minimum amount of metal required to make the shoe and wedge bearing faces central and parallel, is removed. In setting the box on the planer the sides which come next to the wheel hub should be set at right angles to the platen, or the bore may be set parallel with it by testing the side of the bearing with a surface gage. The finishing cuts should leave the faces smooth and flat to insure a good bearing, thus reducing the wear of the box to a minimum.

Frequently, locomotives are equipped with boxes having flanges which taper from the center toward each end, as shown in Fig. 2. When planing boxes of this kind, it will often be necessary to shift them in order to plane out the tapered portion D of the faces, which the tool could not reach on the first cut. It is necessary that these corners be removed so that when the shoe or wedge is placed between the flanges, as shown in the illustration, it can be given a rotary movement, the centers of the flanges acting as a pivot. The reason why box flanges are tapered for the purpose of giving this play between the box and the shoe and wedge, is to prevent the flanges from breaking, and the tapering flange is especially desirable on rough roads. When a locomotive running at a high rate of speed strikes a curve, the relative positions of the wheels and the engine frame are momentarily changed. This change is caused by the elevated track and the inertia of the mass supported upon the springs and the flexibility of the springs. When the wheels come to a curve, the outer ones ascend the elevated outer rail so quickly that the driving-boxes are forced upward against the tension of the springs. If the box flanges were not tapered, permitting this movement, there would be danger of their being broken. Therefore, in re-planing the shoe and wedge bearing faces of a box, the importance of planing out the tapered portions of the faces will be understood.

* * *

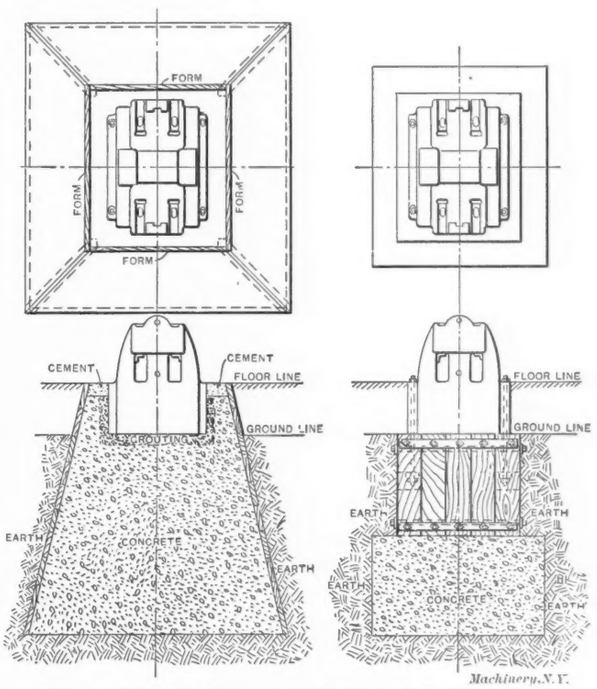
The motor car trade of Germany in 1907 is stated in the British Consular report to be somewhat less than was expected. The supply greatly exceeded the demand, and the heavy cost of repairs is stated to have contributed largely to the bad condition of the trade.

DROP-HAMMER FOUNDATIONS.

The E. W. Bliss Co., Brooklyn, N. Y., builder of drop forge hammers, contributed the following information regarding the construction of drop-hammer foundations.

The endurance and effectiveness of drop-hammers depend in no small degree upon the proper ratio between the weight of the base and the weight of the hammer. It has been demonstrated that 12 to 1 is decidedly better than a smaller ratio, and that the best results are obtained with a ratio of 15 to 1 or 16 to 1 with all parts made in proportion; the extra cost of the heavier machine being more than compensated for by the larger quantity and better quality of the finished product and by the comparative freedom from breakdowns.

For the successful operation of drop-hammers, it is very essential to have a good foundation. Both of the types here illustrated have been found to give good results. The wood cushion foundation, as shown in Fig. 2, is used where the bottom is not good and where the jarring of the surrounding buildings is objectionable. The solid concrete foundation shown in Fig. 1 is recommended as best when it can be used, as it is like a continuation of the base on the hammer, and therefore makes the drop more efficient. In deciding the depth of foundation of either of the above types, care should be taken to determine the best point to stop the excavation. Bed rock is the best bottom, cement gravel next best, and a strata of sand or clay, say 4 feet thick, and in its original



Machinery, N.Y.

Figs. 1 and 2. Drop-hammer Foundations of Solid Concrete, and with Wood Cushion.

and undisturbed condition, also makes a good bottom. The trouble with sand or clay is that on account of the heat of a drop forge shop drying the soil and a continual jar, they are apt to shift provided they get an outlet in the shape of other near excavations. By spreading the bottom of the foundation the desired result is sometimes obtained without going very deep, but for any size of drop-hammer the concrete should not be less than 4 feet thick, whether the wood cushion is used or not.

* * *

In an interesting little pamphlet, published by a German investigator, Mr. Hermann Neikes, regarding the unit of measurement and the system according to which the Cheops pyramid in Egypt was built, the author mentions that he finds that the dimensions of the pyramid and its integral parts are in such proportions as to indicate that the unit of measurement employed was identical with the English foot or, in other words, that the standard length of the English foot has its origin in, and came down to our time from, the standard of length in Egypt about six thousand years ago.

COMPARATIVE TEST OF ABRASIVE DISKS ON CAST IRON.

This test was made at the shops of the Gardner Machine Co., Beloit, Wis., to determine the comparative efficiency for grinding cast iron, of different kinds and makes of disks, such as are commonly used in connection with disk grinders. In the following table the different kinds of disks are indicated by figures:

No. 1 indicates the Gardner improved abrasive disk No. 126, which is further described in this article. No. 5 is the regular No. 24 commercial emery cloth. No. 6 is the same in emery paper. Nos. 2, 3 and 4 are proprietary articles of excellent quality as compared to commercial emery cloth, and all are well known by trade names, being extensively used.

The disks tested were all 20 inches in diameter and all excepting Nos. 5 and 6 were No. 16 grain. The grinding was done on the ends of hollow blocks of cast iron as shown in Figs. 1 and 2. The area ground at the end of blocks was 5 square inches. Reducing the blocks one inch in length, indicated the removal of 5 cubic inches of metal. The grinding was all done on the same machine by the same operator. Fig.

TEST OF EFFICIENCY OF ABRASIVE DISKS.

Disk Number.	Time Used in Minutes.	Stock Removed in cubic inches.	Number of Times Dressed.	Average Cutting Rate, cubic inches per min.	Cutting Rate, First Half of Time Used.	Cutting Rate, Second Half of Time Used.	Life of Disk, Based on Disk No. 1.	Stock Removed, Based on Disk No. 1.
1	754	349.85	0	0.464	0.442	0.486	100. %	100.0%
2	137	42.13	6	0.307	0.344	0.270	18.1%	12.4%
3	540	113.95	0	0.211	0.238	0.184	71.6%	32.3%
4	68	27.97	2	0.411	0.546	0.276	9.0%	8.0%
5	71	2.41	4	0.034	0.062	0.006	9.4%	0.7%
6	73	12.48	2	0.171	0.273	0.069	9.7%	3.5%

3 shows the method of handling the work, and twelve blocks which have been considerably reduced from original length. Usually twelve blocks were operated on together.

The micrometer stop at the back of the table was set to grind off a fixed amount, usually 0.050 inch, and the twelve blocks ground to the stop. The stop was then moved back 0.050 inch and the operation repeated until the blocks became too warm for efficient grinding, when they were cooled, and the time of grinding and the amount of metal removed, noted. This was repeated until the disk was worn out or the blocks all ground up. In the latter case, new blocks were substituted and the operation continued until the disk was worn out. By reversing the blocks they were ground down until the wheel touched the handles on both sides. During this test several hundred pounds of these blocks were converted into cast iron chips.

In the table given above it will be noted that it was necessary to use a Huntington emery wheel dresser on all disks tested except Nos. 1 and 3. The dresser was used whenever

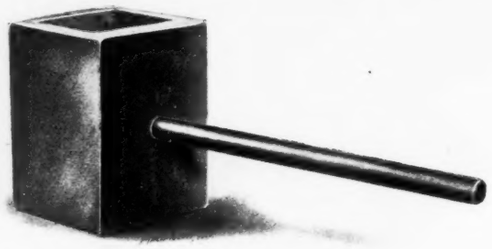


Fig. 1. Form of Hollow Cast Iron Block used for Test.

the surface of the disk became dull and glazed so that it would not cut cast iron readily. The use of a dresser shortens the life of the disk, but it was absolutely necessary. The results obtained are given in the foregoing table.

The disk called No. 1 in the table is made by an entirely new process. The abrasive grains are mixed with required bond and the mixture is cemented to a cloth backing. While in a plastic condition the abrasive grains are *mechanically* tilted to an efficient cutting angle. Careful examination of a disk treated by the tilting process will fail to show any large grains with large flat faces fixed parallel to the plane of rotation. On the other hand, before being subjected to this tilting process a great majority of the grains present their largest flat surfaces parallel to the plane of rotation, *i. e.*, the surface of the work being ground. It is obvious that the flat side of a grain will not cut so freely as a

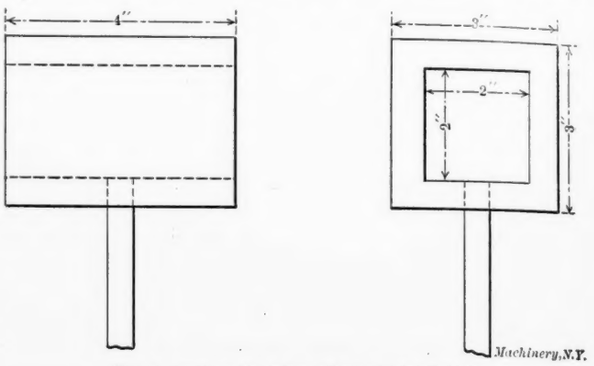


Fig. 2. Hollow Cast Iron Block used for Test.

sharp edge. The truth of this is evident from results shown in the table.

Another very noticeable feature of the No. 1 disk is the uniformity of its cutting efficiency from start to finish. As shown in the table, the disk removed stock just as fast during the last six hours as it did the first six.

All the other disks tested are made by depositing a heavy coating of glue on the backing sheet and then spreading a quantity of dry abrasive grains onto the glue. The abrasive grains settle into the glue and so become firmly attached to the backing sheet. By this process the grains and glue are

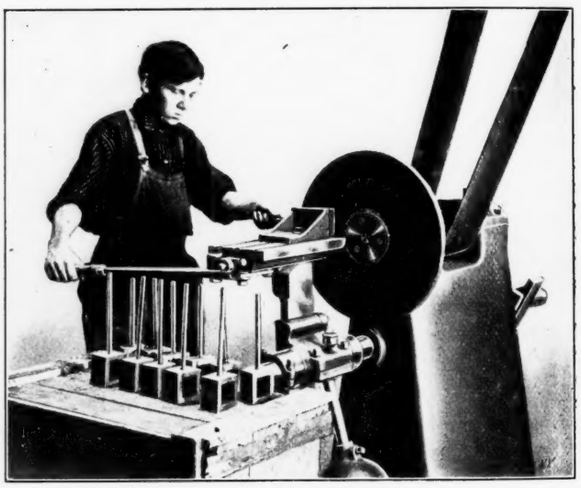


Fig. 3. Method of Grinding Blocks in Test.

not evenly mixed from face to back. Disks made in this way cut freely and rapidly at first, but soon wear down to a point where there is too much glue and not enough of the abrasive grains. This fact is plainly evidenced by record of disk No. 5, in the columns giving average cutting speed for first and second half of the time used.

The illustrations Figs. 4 and 5 show operations on work done with disk No. 1. Fig. 4 shows grinding of impellers for centrifugal pumps. These are gray iron castings and are very rough and hard in places, making them difficult to machine in a lathe. The diameter is 26 inches, and the area of surface ground is about 50 square inches on each side. It was necessary to remove ¼ inch thickness of metal at some points. The rate of grinding these impellers on both sides was fifteen minutes for each impeller. The former time for turning in a lathe was three hours and thirty minutes for each impeller. The pieces are ground at an angle of seven degrees to the axis, and the surface of the blades being curved and not radial, necessitates their being revolved while grinding. This develops the surface of a cone. The impellers are mounted on a spindle driven by a worm gear and worm connected with a hand-wheel, as shown. This fixture is mounted

on a lever feed table set at the required angle with the face of the disk wheel, and the impeller is slowly revolved by means of a hand-wheel while the lever is used to bring it against the disk wheel.

Fig. 5 shows a rather interesting job of disk grinding of special cast iron latticed plates. These plates are used in the manufacturing of the grinding disks No. 1 in the foregoing table, and are required to be accurately flat and of uniform thickness. They are 23 inches diameter by ⅞ inch deep. The rings and spokes that go to make up the plates are 5/32 inch thick. The castings being so thin, it was found to be impracticable to machine them in a lathe or boring mill, but results obtained with a disk grinder are entirely satisfactory.

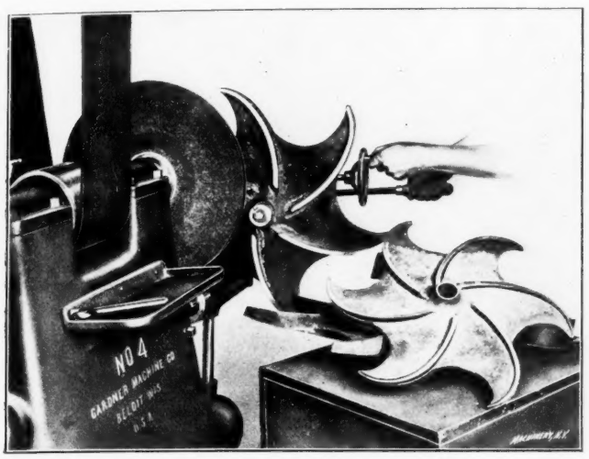


Fig. 4. Grinding Vanes of Cast Iron Impellers.

The plates are chucked at the inner circle, which is about 6 inches diameter, on a metal disk having heads of set-screws projecting from its periphery. This disk has a ¾ inch hole in the center, fitting a stud in the angle plate which is bolted to the top of the lever table, as shown. The latticed plates are hung on this stud, bearing against the angle plate, and are pressed against the disk wheel by the lever. They are, of course, free to revolve with the wheel, but the speed of this revolution is easily controlled by changing the relative position of the stud to the axis of the machine spindle, and also by the hand of the operator, as shown. By changing pressure on the lever and by swinging the table on the rocker shaft the revolution of the plates can be increased, stopped entirely or reversed at the will of the operator.

The castings for the plates are made in a stove foundry and are quite accurate to pattern, but too hard to turn. The amount of metal to be removed to make them accurately flat, is small, averaging less than 1/32 inch each side. By the method shown, they are finished to the required size and made flat on both sides in about fifteen minutes.

Figs. 6 and 7 are reproduced from a photograph of Gardner's improved abrasive disks. Fig. 6 shows No. 1 disk used in the grinding test. Fig. 7 is the same kind of disk, but made of a much finer abrasive and being lighter in color, shows very plainly the corrugated surface which produces the mechanical tilting of the abrasive grains.

* * *

A correspondent of the *Engineering News* says that the greatest inventor and engineer of the nineteenth century, whose inventions have spread over the civilized world, once said to him: "If people knew how little I know, they wouldn't come to me for advice." Think of a lawyer or doctor or a "man of affairs," whatever that may mean, making such an admission to a client. Does the experience and training of the engineer, which constantly forces him to honestly deal with the laws of nature which underlie all his work, produce a type of man that is more honest, simply on account of his technical training and the influence of the work to which he devotes himself?

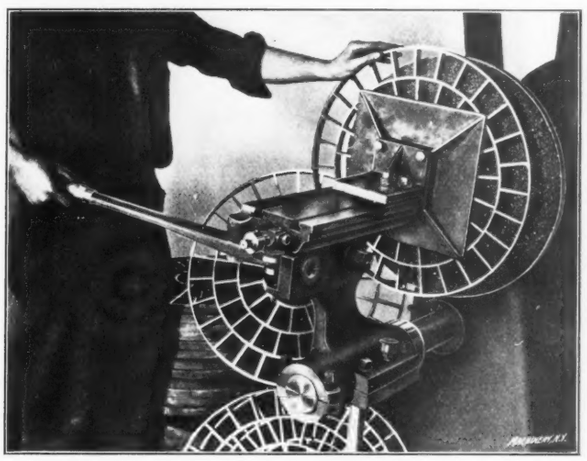


Fig. 5. Grinding Sides of Latticed Plates.

Fig. 6. Improved Grinding Disk with Coarse Abrasive Grains Mechanically Tilted.

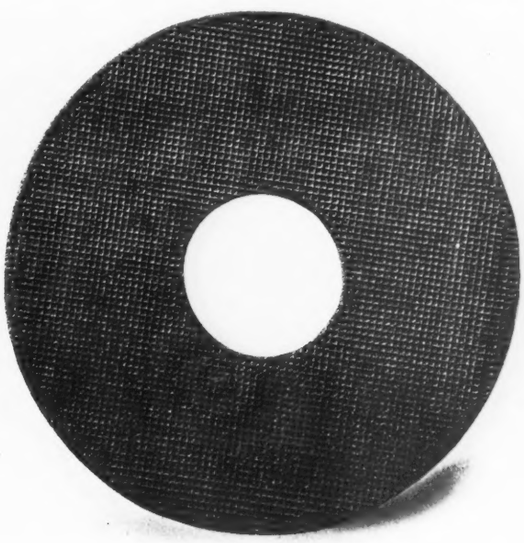


Fig. 7. Same Type of Grinding Disk as shown in Fig. 6, but with Finer Abrasive.

* * *

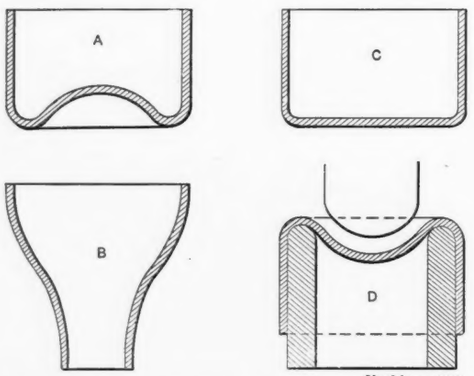
Tracings and drawings that have been rolled up can be flattened by rolling them in the reverse direction from that in which they have been kept, forming the roll into a conical funnel shape, and holding the wide end over the flame of a lamp, so that the hot air can circulate over the surface of the drawing. When unrolled, the drawing will be found to lie flat.

LETTERS UPON PRACTICAL SUBJECTS.

SHEET METAL DRAWING.

Only those who have made a specialty of drawing sheet metal know just how to proceed to lay out a die so that the desired result will be a certainty the first time it is tried. Recently the writer has had quite a little experience on this class of work and a few of the kinks that I discovered and some which I had explained to me by others, follow.

First, we are confronted with finding the diameter of the blank. There are several methods by which we can determine the size of the blank. One way is to cut out a blank of the same thickness as the stock of which the model shell is made, and then keep reducing the diameter until the blank balances the model. Another way is to multiply the circumference by the height and add the area of the bottom, which gives the area of the blank, then find the diameter of a circle whose area is equal to the area found. This latter rule applies to blanks that must be of a uniform thickness on the sides and bottom. But if the article should be an ordinary box or something allowing a variation of thickness, the size of the blanking die can be much smaller. By this, I mean that a shell 3 inches long can be drawn from a blank 3 inches diameter, or from a 2-inch blank. The sides and bottom will, of course, be thinner. A good rule to follow is to make the height of the shell at first draw, one-third the diameter of the blank, that is, a 3-inch blank, for best results, should produce a shell 1 inch long at first draw. The shells should be annealed if drawn to any length.

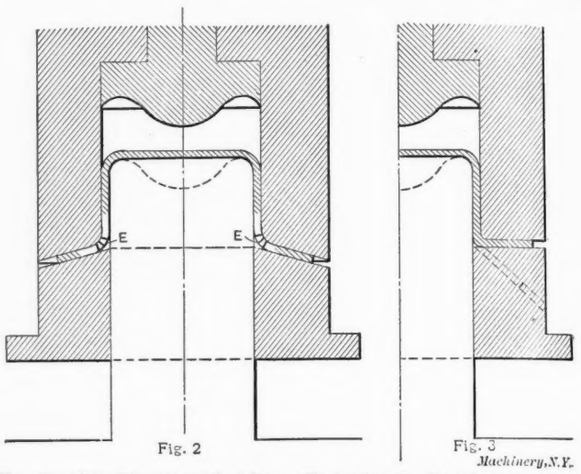


Machinery, N.Y.

Fig. 1. Method of Drawing Shells which gives a Minimum Variation in Wall Thickness and a More Even Distribution of Stretch.

Fig. 1 shows a novel kink when the blank is to be drawn into a shell of length or into a shape as shown at *B*. The first operation leaves the shell as shown at *A*, and this will save at least one drawing operation. It will be noted that the indented end in the shell bottom presents surplus stock, so to speak, whereas, if it is drawn at the first operation in the ordinary way as shown at *C*, the succeeding operations must be gentle to prevent a greater reduction in the thickness of the walls on the angular sides of the shell. Another advantage in shaping the first shell as shown at *A*, is that when drawing it to the angular shape, the stretch or draw of metal is more evenly distributed over the entire surface and the strain on the metal is not as great as if the draw commenced at the corner. Another novel feature (to the writer) is to shape the blank as at *A* (if the shell is to be a long one) and then use a die for the second operation, as illustrated at *D*. The blank, when forced through, is actually turned inside out. This operation presents two good points to the writer. First, we are enabled to get a suitable amount of stock in the shell in such a shape as to draw to the best advantage. Second, if the shell is to be a long one, the diameter of the blank must of necessity be large, therefore the stock is distorted considerably in changing from a flat blank to a shell of much smaller diameter, and if we could see the grain of the stock as it passes over the die, it would present an appearance similar to that shown by the lines *E* in Fig. 2. That is, the inside of the stock stretches and the outside compresses. Therefore, by turning the shell inside out, the stock is apparently restored somewhat to its original texture of close grain, which will allow further stretching.

A very important point which must not be overlooked is the angle on the face of the stripper and blanking punch. I have found that in making long, small diameter shells, that if the angle on the stripper and blanking punch is, say 8 degrees, every shell would break out at the corner; but by changing the angle to 10 or 12 degrees, that they would come out without breaking. This point can be better understood by referring to the half section, Fig. 3. It would be almost impossible to draw the shell when the edges of the blank were at right angles to the shell, but by making the angle of the punch and stripper as shown, exaggerated by the dotted lines, the shell is practically drawn by the blanking punch, and leaves very little work for the drawing punch.



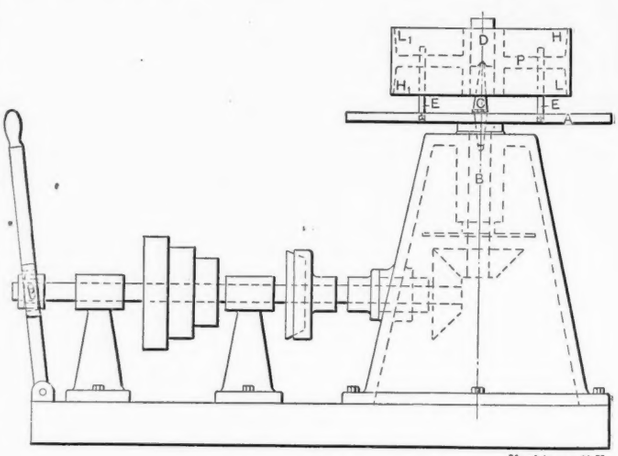
Machinery, N.Y.

Figs. 2 and 3. Diagrammatical Views illustrating the Stretch of the Metal and the Effect of Angular Punch and Stripper Faces.

Pittsfield, Mass. FRANK E. SHAILOR.

PULLEY BALANCING DEVICE.

Most machinists have, at some time or other, met with problems in balancing which have been difficult to solve. It is easy to obtain a fairly accurate static balance on a pair of parallel ways, in the ordinary manner, but if the pulley or other part to be balanced is wide, and runs at a high speed, this method is not altogether satisfactory, as one edge may be heavy on one side of the pulley, and the other edge on the opposite side. When this condition is present, there is a vibration when the pulley is running at high speed, which causes unnecessary strain on the shaft on which the pulley is mounted, and on the adjacent bearings. The writer lately saw an old machine designed for obtaining a running balance, which may be of interest to some of the readers of MACHINERY.



Machinery, N.Y.

Device for the Dynamic Balancing of Pulleys.

An outline of this machine is shown in the accompanying line engraving.

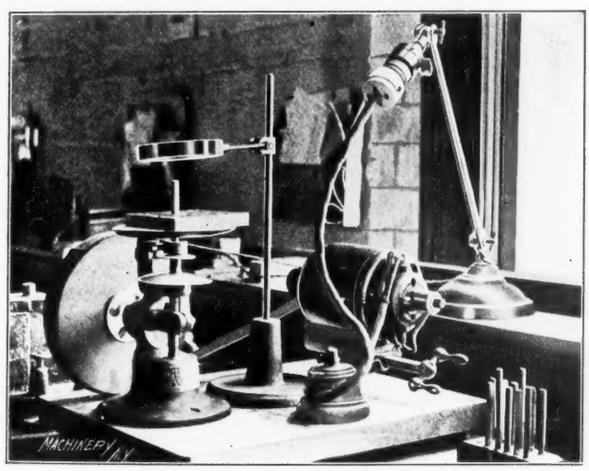
The lower part of the illustration shows the frame and the driving details. At the right-hand end is a stand on which is mounted a plate *A*, which is, by suitable means, fastened solidly to the shaft *B*, and revolves with it. Into this plate and shaft is inserted a taper pin *C*, having a round point at its upper end. In the plate are further inserted two rods or pins *E*, which are screwed into holes about half-way between the center and the outside periphery of the disk *A*. These pins serve to drive the pulley *P* being balanced.

In balancing a pulley, the static balance is first approximated by the usual methods. A plug *D* with a large center is then driven into the bore in the pulley, so as to extend about half way through the hole, and the work is then placed on the machine in the position shown in the engraving, the center of *D* resting on the round point of *C*, so as to bring the latter approximately to the center of gravity of the pulley. If we now assume that the points *H* and H_1 are the heavy points, then, when the machine is started, these points will throw outward, on account of centrifugal force, and the pulley will assume a tilted position, *H* moving downward, and H_1 rising until a state of equilibrium is reached. The pulley can then be marked by a piece of chalk. After marking the pulley, the machine is stopped, and weights added in equal quantities on opposite sides at *L* and L_1, or metal may be removed at *H* and H_1, whichever is most convenient. If either *H* or H_1 comes in line with the weights used for static balance, these weights can be moved up or down, whichever is required, producing the same results. Now the machine is started, and the pulley is tried again, and the balancing process repeated until it will run truly balanced at full speed.

ALLAN.

A HANDY FILING MACHINE.

The engraving illustrates a very convenient filing machine which is in use in the Remington-Sholes typewriter factory, for filing dies. It consists of a small filing machine to which an old center grinder has been attached by means of a couple of wood pulleys and a belt. The whole thing is mounted on



The Filing Machine with a Reading Glass mounted above it.

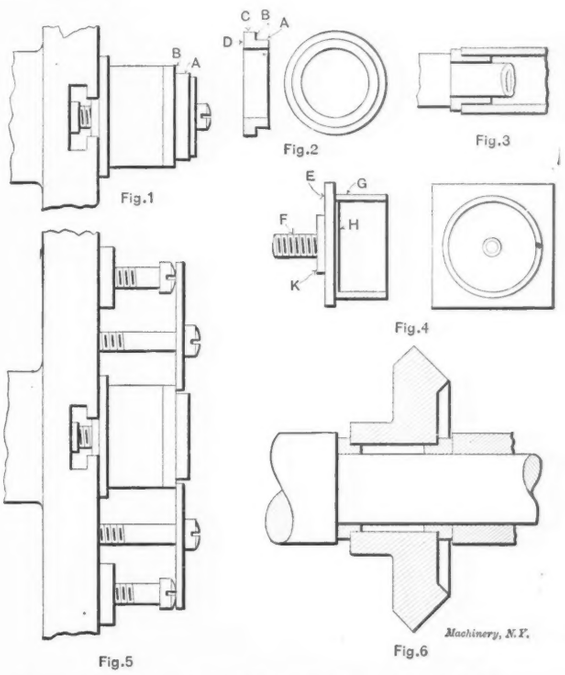
a cast-iron base and may be moved anywhere and attached to an electric light socket, and it is ready for use. The engraving also shows a very good way of using a large reading glass. The mount for this, of course, being movable.

Decatur, Ill. ETHAN VIALL.

SMALL ACCURATE FACE-PLATE WORK.

Not long ago I had some soft steel bushings to make, as shown in Fig. 2, where the part *A* was to be concentric with the hole, and the faces *B* and *D* flat and parallel, and square with the hole. The part *C* was not particular, and was left with the finish of the original surface of the cold rolled shafting of which they were made. There were four sizes of these bushings, and only two of each size to be made. They were to be put on milling machine arbors used for holding bevel gear blanks when cutting the teeth, as shown in Fig. 6, thus making each size of arbor do for more than one size of hole. I wanted to make a rather accurate job of them, and not let an error of over 0.0002 inch creep in, if I could help it. As this is not an unusual type of job, I thought a few simple fixtures could be made that might afterwards be used on similar jobs where considerable accuracy was required.

For ordinary work these bushings would be turned on an arbor between centers, as the holes were standard sizes, but I thought a more accurate job could be done on the face-plate of a bench lathe, so that was the way I adopted. My draw-in chuck for the bench lathe was fitted some time ago with a



Miscellaneous Views showing Piece to be machined, its Use, and Method of holding to Face-plate.

reducer and auxiliary draw-spindle to take the smaller sized chucks of a watchmaker's lathe, and I found that by taking out the main draw-spindle and putting in the auxiliary draw-spindle alone, the front end of it fell a little short of coming through to the front of the face-plate, so I made a bushing as shown in Fig. 3, making the hole to fit over the auxiliary draw-spindle, and the outside of the bushing to fit the back end of the hole in the lathe spindle. This bushing kept the auxiliary draw-spindle central, and gave it a shoulder to work against. The piece shown in Fig. 4 I have called a false face-plate, for want of a better name, and of these I have three different diameters at present. *E* is made of square brass rod for the small sizes, and thick sheet brass for the larger sizes. It has a round hub *K* turned on the back that is an easy fit in the regular face-plate. There is a hole tapped all the way through *E* the same size as the threaded part of the auxiliary draw-spindle. The steel stud *F* is threaded its entire length, screwed through *E*, and sweated and riveted tightly into it. The front end of *F* has a small hole tapped in it, while the front end of *E* has a boss turned on it which is an easy fit in the bore of the short piece of seamless brass tubing *G* which is sweated fast to *E*. In use, the false face-plate is held tightly against the regular face-plate by the auxiliary draw-spindle taking hold of the stud *F*, and a light cut is taken over the outer face of *G* just before clamping the work on it. This gives a face-plate that is easily trued up just before using, and on which work may be clamped either by four clamps on the outside, or by a large washer and screw inside. The bushing shown in Fig. 2 was first held in a cast iron step chuck, bored to size with a slide rest tool, and *D* was faced, after which the shoulder was roughed out on an arbor between centers. The bushing was then lightly held against one of the false face-plates by a screw and washer, as shown in Fig. 1, and shifted about until it ran

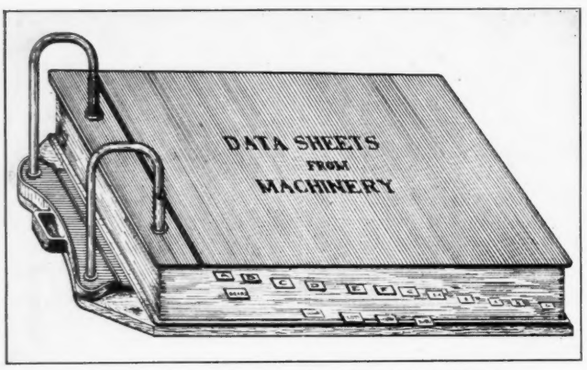
approximately true, after which four clamps were arranged around the outside, one for each T-slot; two of these clamps are shown in Fig. 5. The central screw and washer were now removed. This gave free access to the hole, and a dial indicator applied to the bore told when that ran true. Then the outer clamps were tightened and another look was taken at the indicator to make sure that nothing had shifted during the final tightening of the clamps, after which the central screw and washer were replaced, screwed home tightly, and the outer clamps removed, which gave free access to the outside, so the diameter *A* and face *B* (Fig. 2) could be turned.

Of course, in doing work in this way, only light cuts can be taken, for a heavy cut might cause the work to shift. The brass tube *G*, Fig. 4, is a piece generally taken from the scrap box. After considerable use, tube *G* will be gradually turned off until the outer end is about flush with the front of *H*. When this occurs, the remains of *G* can be "soldered off," as a Teutonic friend of mine used to say, and another piece of tubing soldered on in its place, thus giving the device a new lease of life. *G* is made of brass because it solders easier than steel, and also because a more accurate cut can be taken from brass, as less pressure is required to keep the tool to the work. The lack of durability is of no importance, as the working face of *G* is supposed to be trued up immediately before using. WALTER GRIBBEN.

Brooklyn, N. Y.

FILE FOR MACHINERY'S DATA SHEETS.

The accompanying engraving illustrates a scheme which I have found very useful for filing and indexing, in a systematic manner, MACHINERY'S data sheets. An ordinary arch file is used, small, rectangular pieces of paper pasted at the edge of the data sheets being used for indexing purposes. In the



Convenient Method of filing Machinery's Data Sheets.

front of the file is placed the alphabetical index of contents supplied with the data sheets, and in addition to this index I have a supplementary alphabetical index for the sheets that arrive from month to month. This gives all the advantages of a loose-leaf notebook, permitting new sheets to be conveniently added and indexed. SAMUEL G. AROSON.

Philadelphia, Pa.

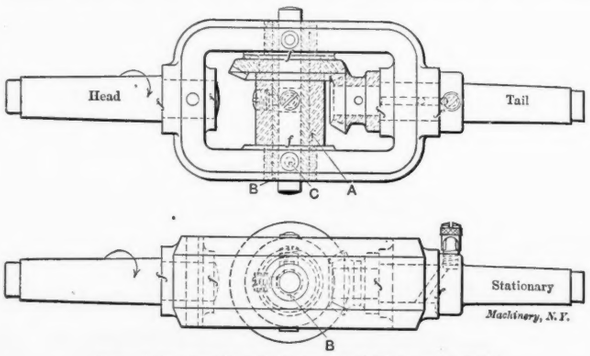
DOES PREMIUM WORK ALWAYS PAY?

The writer asks the question, Does premium work always pay? because of a case which recently occurred in the factory where he is employed. One of the articles manufactured consists of drawn steel pieces from which the bottom end is cut off after the drawing process. The shape of the drawn part or cup is elliptical, the long axis 3½ inches, the short axis 2 inches, and the thickness of the metal 0.109 inch. The operation of cutting off the bottoms from these cups is performed on a plain milling machine, using saws made from Novo high-speed steel, the saws being about 8 inches in diameter and ⅛ inch thick. While being cut off, the pieces are held in a fixture, and a single movement of the lever locks or releases them, so that very little time is consumed in putting them in the machine and taking them out.

The rate fixed for the cutting off of these pieces was 50 per hour, and a bonus was offered at the rate of ⅛ of a cent for each additional piece. Recently one operator cut off 2,050 pieces in a day of 10 hours. This, of course, looks all right on the face of it, but in doing so he dulled three saws, and it takes four hours' work for the tool-maker to recut one of them. Therefore, the point I raise is this: Is it profitable to allow a man to work the tools beyond their limit of endurance in this way? It is actually costing more to do the work at this speed than it would working at the speed at which the saws would stand up to the work for a longer time. W. ALTON.

GRINDING FIXTURE FOR END MEASURE RODS.

The fixture shown in the illustration was made to grind spherical end measuring rods 3 inches long, and over. There were three diameters of these rods, ⅜, ½ and ⅝ inch, and three sizes of fixtures were also made to suit. Steel sleeves *B* were made of various lengths for each fixture, to stiffen the rods near the end when grinding. These sleeves had a bearing at each end in hardened bushings which were driven



Fixture for Grinding Spherical End Measuring Rods.

into the fixture body. The sleeves were kept from turning and from sliding endways, independently of the gear, by the tit-screws shown. These screws, in addition, held the rod being ground. Member *A* was a tight fit in the large bevel gear, being made separate to allow of cutting the gear teeth. The flush oilers *C* were placed on opposite sides of the body, so the tendency to throw oil would be done away with as much as possible.

A feature apt to be overlooked is that the numbers of teeth in the two gears must be prime to each other. If not, every certain number of revolutions, depending on the gears used, the wheel will grind into one of the previous cuts. The fixtures were arranged to be used on a bench-lathe, with a tool-post grinding fixture.

Brooklyn, N. Y. G. R. RICHARDS.

VALUE OF COOPERATION.

In a drafting-room in which I have been employed, there were five draftsmen, including myself, and being interested in many technical magazines and in the habit of subscribing for them, I thought of a method by which I could benefit my fellow draftsmen as well as myself. I proposed that we each give 25 cents a month, and, when a sufficient amount was obtained, subscribe for one of the many technical magazines. In this way, at the end of a year, we had a total of $15 worth of magazines at a cost of only $3 a person. The magazines that we subscribed for were: MACHINERY, *American Machinist*, *Industrial Magazine*, *Popular Mechanics*, and *Engineering News*. We made the agreement that if any of us left at any time we should waive all claim on the magazines and leave them as the property of the office, the inference being that we received our money value in the number of magazines we each had an option on for the time we were employed, and for the money expended. If this cooperation was instituted in large drafting-rooms where there are from ten to twenty-five or more draftsmen, one can readily see how much could be collected and how many magazines could be subscribed for. There would soon be established a small library of magazines, which, if kept properly indexed, would form the foundation of a valuable information bureau, which I think the employers would not object to providing a space for, and they might even

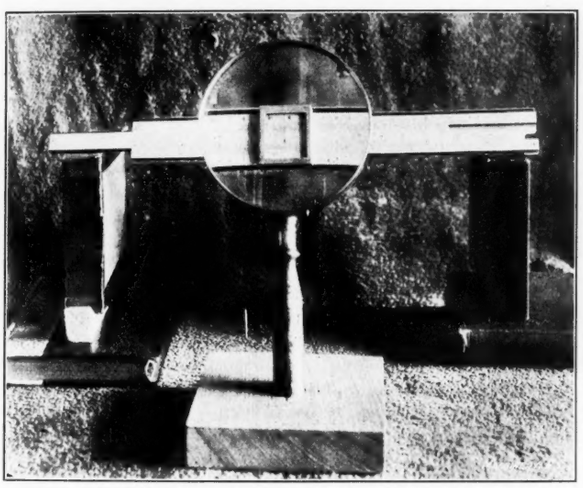
cooperate in the matter. This method could also be instituted in the machine shop, and where there are from one to two or three hundred men they would only be required to give 10 cents a month. The management could be placed in charge of a committee who would take care of all money and the necessary details. It is surprising to see how this idea will develop, and the enthusiasm felt among the men. I have never seen this method in operation except in the drafting-room where I was employed. It is a case where an investment is repaid many fold, and shows the value of cooperation.

Roxbury, Mass. WALTER J. BITTERLICH.

[It is quite evident that the cooperative scheme which has been suggested is not as valuable as it might appear on the surface. Of course, a number of publications can in this way be secured at a low cost per capita, and, in time, there would be a valuable collection of technical literature which would be useful for reference purposes, but, unfortunately, draftsmen and mechanics are not in the habit of staying in one place a lifetime, and consequently the firm alone would be permanently benefited. The man who does not file a technical publication for which he subscribes loses a large part of its value, and while the cooperative method enables him to see a number of good magazines, he is deprived of their use as soon as he goes to work elsewhere. For this reason we believe that it is better to subscribe outright for one first-class technical paper than to have a part interest in half a dozen.—EDITOR.]

READING THE SLIDE RULE ACCURATELY.

A simple device for reading the slide rule more accurately than can be done with the naked eye is shown in the accompanying photograph. The magnifying glass is set in a base,



Stand with Magnifying Glass for Reading the Slide Rule accurately.

as shown, at an angle of 60 degrees. The base is of wood 4¼ inches square and ⅞ inch thick. I have found this a very convenient method for getting closer readings.

Lockport, N. Y. C. H. CORNES.

METHOD OF LEVELING A LINE SHAFT.

We once had a job of putting up a line shaft in a long building, and it was quite necessary that the bearings should be level. There were no engineering instruments about the plant with which to level the shaft, and it was thought that a long wooden straight-edge with an ordinary level was not accurate enough. We were about 400 miles from home and in a small town where we could not get an engineer's level, and were at our wits' end to know what to do without sending to our factory for, or renting one from the nearest city, about 25 miles distant.

We finally got a length of ½-inch hose about 20 feet long, and fastened a regular boiler gage glass to each end. Then we poured in water until it showed about half way up in either gage. One gage glass was then held with the water level at the required height of the center of the shaft and the next hanger set with its center even with the level of water in the other glass. This gave us a very accurate way of setting our brackets, as we had practically a U-tube 20 feet between glasses. When our line shaft was put up, it worked splendidly, and we never heard any complaints.

This was the first time I had ever heard of such an apparatus being used, but there is no reason why it could not be used for getting levels for setting new machinery, piping, or, in fact, anything where the distances are at all long between supports. It can also be used to set shafting at the same level in different rooms, around a corner where the view directly across is obstructed, or in almost any place imaginable. JULIAN D. PAGE.

Youngstown, O.

METHOD OF ACCURATE DRILLING.

Although much time can be saved by the use of drill sockets so constructed that drills can be slipped in while the spindle is revolving, the work does not always come out satisfactorily accurate unless the bushing in the jig is exactly central with the drill spindle. In the shop where the

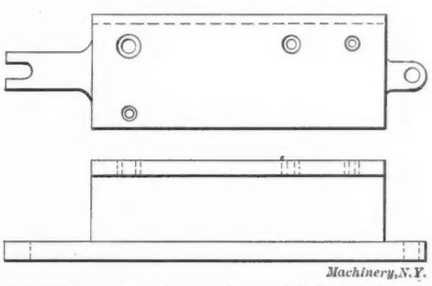


Fig. 1. Outline of Jig for which Jig Plate in Fig. 2 is used.

writer is employed, such sockets are used almost exclusively, but trouble has been experienced with the holes not always being in alignment.

To overcome this trouble, a jig plate, such as is shown in Fig. 2, was made for the jigs, and the work comes out much better, and fewer drills and reamers are broken, because this jig plate makes it possible to have the bushings for each hole, when drilled, in perfect alignment with the spindle. Fig. 1 shows a lay-out of a jig used in drilling exhaust rockers for small gas engines. All the holes are reamed, removable bushings being used for this purpose. The jig is cast with an extension at each end on the bottom side. One of these extensions is slotted, and fits over short pins, shown at A, A_1, A_2 and A_3, Fig. 2. The other end has a hole, to take a taper pin, which enters into the holes A',

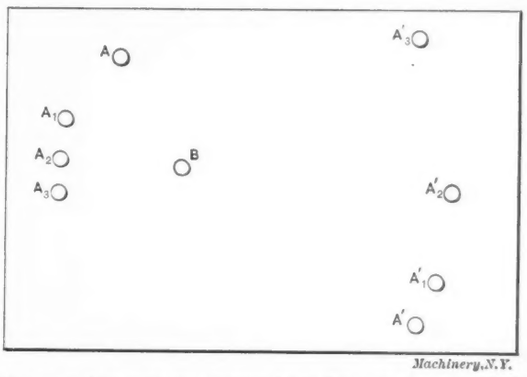


Fig. 2. Jig Plate used for Locating Jig in Fig. 1 on Drill Press Table.

A'_1, A'_2 and A'_3 in the plate, when the slotted end has been placed with the corresponding pin on the other side of the jig plate.

These pins and holes are so located that the jig, when placed between correspondingly located pins and pin holes, will be held in such a position that one of the bushings in the jig will be exactly in line with the drill spindle, provided the plate is originally clamped on the drill table correctly, so that the position of the small hole B is exactly in line with the center of the spindle. When this plate is in use, the jig is first put on the plate with the pin A en-

tering the slot, and the hole in the other lug of the jig is placed over hole A', and the taper pin put in to hold the jig in position. The corresponding hole in the work is then drilled and reamed. The jig is then changed so that the slot in the lug fits over pin A_1, and the taper pin in the other end of the jig is changed to the location A_1', the second hole then being drilled and reamed. In the same manner, any number of holes may be drilled. Jigs with holes at right angles to each other must, of course, have lugs cast on two sides. In the engraving, no binding devices have been shown, as it is not necessary to indicate the design of the jig itself in order to explain the principles of this jig plate.

Y. ZIEGLER.

RACK FOR CHANGE GEARS.

The way we mount change gears in our lathe legs is illustrated in the half-tone and line engraving. There are two lugs cast in the leg, and the change gears are held on a steel rod

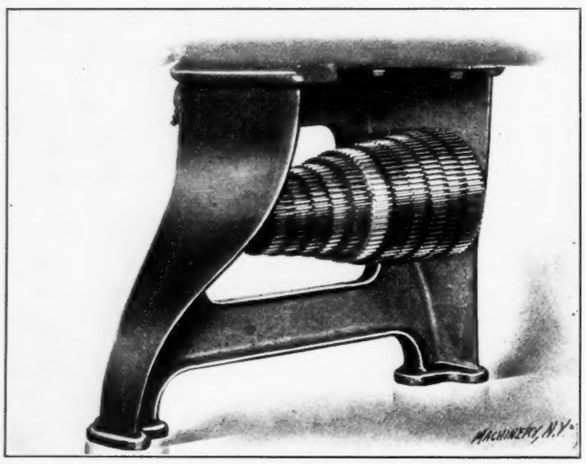
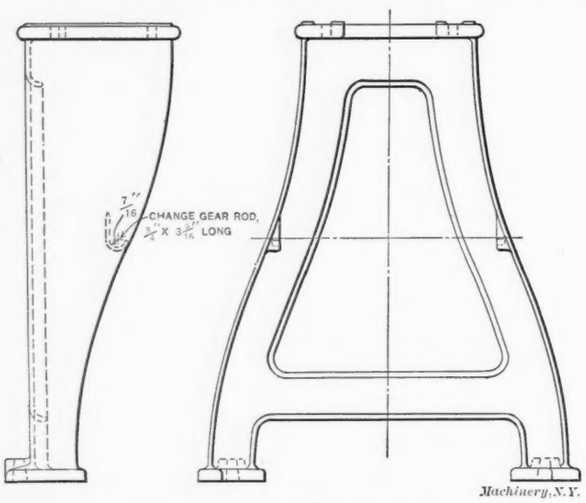


Fig. 1. View showing the Change Gears stored beneath the Lathe.

which hangs on these lugs. This makes a very convenient method of keeping the gears clean and at the same time in position where they can be quickly taken off for use. This scheme is new to me, and I thought that perhaps some of the



Lugs for Holding the Rack in Place.

readers of MACHINERY might use this device on their lathes. Of course, they could bolt little hooks to the legs instead of casting lugs on them as we have.

WM. F. GROENE.

Cincinnati, O. R. K. Le Blond Machine Tool Co.

OBTAINING THE HEIGHT OF THE MIDDLE ORDINATE OF AN ARC.

In the March issue F. M. S. gave a method for finding the length of the middle ordinate of a circular arc, given the chord and the central angle. The Editor's note remarked the fact that there are three operations in the solution, of which two are divisions. It was also, and very justly, stated that it is generally easier to multiply numbers than to divide them. By a slightly different method it is possible to reduce the operations to two, of which one is still a subtraction, and the other is a multiplication. The rule given by F. M. S., written as a formula, says:

$$h = \frac{C}{2 \sin x/2} - \frac{C}{2 \tan x/2} \text{ where}$$

C = length of chord,

h = length of middle ordinate,

x = central angle.

Substituting for $\sin x/2$ its equal $1/\text{cosec}\ x/2$ and for $\tan x/2$, $1/\cot x/2$, the equation becomes

$h = C/2\ \text{cosec}\ x/2 - C/2\ \cot x/2$, or putting $C/2$ outside a parenthesis,

$h = C/2\ (\text{cosec}\ x/2 - \cot x/2)$, or, expressed in words, the height of the middle ordinate equals the difference between the cosecant and the cotangent of half the central angle, multiplied by half the chord length.

New York. H. S. QUACKENBUSH, JR.

SELF-OILING MACHINERY.

It is always somewhat dangerous to differ with an editor, but to go against an editor and against self-oiling machinery at the same time is a piece of pure devilish recklessness. However, human nature is such that recklessness appeals occasionally even to the most timid, and this, in short, is the reason why I am trying to lift my voice in protest to your editorial under the above heading in the July issue.

Self-oiling machinery is very nice. There is hardly anything in the whole machinery line which can so easily be talked up, and for that reason alone it deserves the appreciation of machinery salesmen if of nobody else. Like a great many other things, the trouble comes afterwards. If I had a shop of my own and a lot of self-oiling machinery in that shop and also an oil-can, I would send the first man I hired for that oil-can and have him go carefully over the self-oiling machinery. Of course, I know that a great many of the most improved steam engines, air-compressors, pumps, and other machines, are made self-oiling. But one should not forget that there is a man in charge of this machinery whose main duty it is to inspect the machinery, practically speaking, constantly, and if anything goes wrong with the self-oiling system, the man is there with an oil-can ready to take the place of the automatic device. If things were arranged in the same way in the machine shop, I would not object so strongly, but this would mean that there must be a man going constantly from machine to machine, inspecting not only the self-oiling device, but especially the gears, bearings, shafts, and so forth, and who must be ready to oil the machines or any parts of the machine if the oiling mechanism has broken down.

Of course, the salesman may tell you that there is really no possibility of the self-oiling system breaking down, but you and I who have been "up against it" know better. We know that there is nothing in this world, and especially in a machine, that will not break down occasionally. The oil-pump may break, or may wear, or spring a leak, the oil pipe may get clogged up, a bug may be forced in one of the pipes, and a thousand other things may happen which temporarily throw the oiling system out of commission, and there is no way of finding it out except when the machine stalls on account of a hot bearing.

From the above, it may seem that I am in favor of having every machine operator hover all the time over his machine, looking to the left and squirting oil to the right, but this is not the case. Personally I am in favor of having the system of oiling machines well regulated; and employing a man whose sole duty it is to look after the oiling of the machines, and to see that the man actually oils the machine and not the floor space around it. And I would have one or two or three men according to the size of the shop, doing this work, become expert at it, and be held responsible for every hot bearing in the place, and as I said before, if I had self-oiling machinery I would have the man just the same.

There are certain advantages connected with self-oiling machines in a power plant, which recommend this arrangement,

but if the engineer in charge of the plant ever gets into the habit of thinking that the automatic oiling arrangement will do the work and that he can read his newspaper in peace, he will soon find out in which corner trouble brews, and it will not be very long before his name will be known no more in that power plant. The main advantages are: saving of oil, uniform, constant, and abundant lubrication. In fact, the main advantage is the flooded lubrication which cannot possibly be given by means of the oil-can. As far as machine tools are concerned, these same advantages would be worth a great deal, but they would be as nothing compared with the trouble of the machine stalling, even once, on account of some little defect in the oiling system.

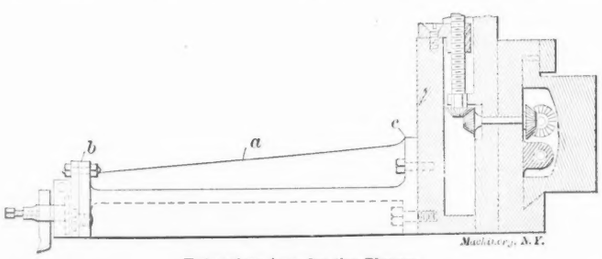
I am not much of a mind reader, but I am willing any time to bet five cents against a nickel that in writing the editorial, the editor had in mind a certain machine advertised in the technical papers mainly for its self-oiling features. The advertisement states that this machine needs to be oiled only once or twice a year, and I presume that the advertisement meant to express the idea that once a year is a good deal better than twice. Now I am of the opinion that to oil a machine only twice a year is bad enough, but to oil it only once is simply horrid. It seems to me that the oil must be so badly deteriorated at the end of a few months that it is absolutely worthless for lubrication, though it may still be good for advertising. Just think of how well bearing No. 6 is lubricated by oil which has been pumped over a lot of bearing surfaces for nearly a year and which carried with it all the grit and dirt and general unrighteousness of the five bearings situated above. And apropos of this machine I notice that the "ad" called the machine self-oiling, whereas in fact, the greater part of the machine must be still treated with homeopathic doses of oil administered by Dr. Oil-Can. I wonder if this same thing would not be the case with practically all machine tools if the so-called self-oiling system were applied to them.

I would like to go into this matter more thoroughly, but this would require more space than I can expect MACHINERY to give when I am hammering at an editorial, and I prefer to call this matter to the attention of the reader and get his opinion. This much I am prepared to say without hesitation: "No self-oiling arrangement for me, except where all the parts to the self-oiling system are constantly and absolutely accessible, and are located in such a way as to be readily inspected and repaired; simple means provided for frequent renewals of the oil, and further, no self-oiling arrangement unless there are also the old-fashioned means for oiling in the old-fashioned way with the old-fashioned oil-can.

Cincinnati, Ohio. A. L. DELEEUW.

EXTENSION ARMS FOR PLANING WIDE WORK.

The article in January issue of MACHINERY entitled, "How a Large Casting was Planed on a Small Planer" recalls to the writer's mind his experience in planing a somewhat similar casting on a 24 x 24-inch Gray planer a few years ago. The



Extension Arm for the Planer.

overhanging end of the casting was guided by rollers in the same manner as was the casting referred to in the January issue, but the length of the surface to be planed in the direction of the planer travel was so great as to necessitate the use of an extension arm on the planer cross-head. The accompanying engraving shows the design of the arm. This design is not original, but is merely one of those old ideas which need to be resurrected occasionally, in order that the rising generation may have the benefit of past experience. These arms, or extension heads, as some mechanics would call them, may be constructed with so little expense that there is small excuse for the bent forgings that are sometimes used instead. The writer found use for two, one about 10 inches long, and the other 20 inches long. The pattern may be produced very quickly as follows: Glue together three boards in the form of an inverted rectangular trough, using boards about ⅜ to ⅝ inch thick, and of suitable length to answer for the job in hand, or any prospective job of reasonable dimensions. The width of the trough should be about equal to the width of the rectangular part of the clapper-box, and its depth may be about the same as the depth (vertical dimension) of the latter. The trough should be closed at the two ends with rectangular pieces about ⅞ to 1⅛ inch thick, and of such width and length as will give ample room for the bolts, as indicated in the engraving. If the pattern be parted in the plane of the top surface of the trough, a light rib *a* will hold the loose pieces *b* and *c* together, and at the same time add strength to the casting. But if the upper portion be given plenty of taper, the cope may be lifted without making the pattern in two parts.

The work of machining the casting is as simple as that of making the pattern. The two ends may be faced in the lathe, on centers, and they should be marked for drilling by the holes in the clapper-box. The bolts which are ordinarily used to hold the clapper-box to the vertical slide will serve to hold it to the outer end of the arm, other bolts being used to secure the arm to the slide. W. S. LEONARD.

Atlanta, Ga.

INFORMATION FOR CUTTING SPIRAL GEARS.

The engraving shows a facsimile of a blue-print blank which I have found to be very handy in giving information to milling machine hands when cutting spiral gears. As will be seen, all necessary information concerning both gears and

Mach. No. 60 — Part No. 60-109
Open Hearth Steel — 100 Gears, 100 Pinions
For:- October 13. 1908

	Gear	Pinion
No. of teeth	20	17
Pitch dia.	2.857"	2.428"
Blank	3.101"	2.672"
Angle of teeth with axis	30°	30°
Normal cir. pitch	.3885"	.3885"
Pitch of cutter (dia.)	8.086	8.086
Depth of tooth (D"+f)	.2654"	.2654"
No. of cutter	4.	4
Exact lead of spiral	15.543"	13.211"
Gears on Milling Mach. to cut spiral	13+S.Mill.Mach.	
Gear on worm	64	72
1st. Gear on stud	32	24
2nd. " " "	56	44
Gear " screw	72	100

Card giving Information for the cutting of Spiral Gears.

pinions is given, together with the required change gears for the machine. In this way all confusion is avoided and the work facilitated. L. H. GEORGER.

Buffalo, N. Y.

PATENT RIGHTS IN TECHNICAL DESCRIPTIONS.

I wish to say a few words regarding a practice which seems to be increasing in the technical press, and that is the growing custom among writers of illustrating and describing patented tools or other articles without mentioning the name of the patentee or maker, or without referring in any way to the fact that they are patented. Not only is this practice an injustice to the inventor or manufacturer because of not giving credit for what he has done—corresponding to plagiarism in literature—but it tends to break down the little protection now afforded by the patent laws. It carries to the mind of the reader the impression that there is no patent on the article described. This is not fair to those who have spent time and money in developing an article and placing it on the market.

An illustration of this practice is found in the July issue of MACHINERY in the article "Special and Adjustable Taps" by your associate editor, Mr. Erik Oberg. Fig. 9 shows the Pratt & Whitney method of securing the blades in its expanding reamers, and Fig. 10 shows the way the inserted blades are held in its large milling cutters. Both of these constructions, I understand, are covered by unexpired patents.

Cleveland, Ohio. J. G. MATTHEWS,
Cleveland Twist Drill Co.

[It is not practicable for the editor of MACHINERY to investigate the status of patent rights on all the tools and devices illustrated in its columns. In fact, it is difficult enough for a court of law to decide these perplexing matters, oftentimes. To avoid complications we generally ignore patent rights, leaving them to the investigation of parties interested in the manufacture and sale of the device shown. Scrupulous and prudent manufacturers would not engage in the making of any tool or device without knowing its status in the patent office, while the unscrupulous are not likely to take much heed of the warning "Patented ———" if they think an infringement can be successfully made and sold without prosecution. In the case referred to by Mr. Matthews, the fact that the reamer construction is patented was mentioned in the article "Adjustable Reamers and Taps with Inserted Blades," July, 1907, this article being referred to in the July, 1908, issue. Our contributors will confer a favor by always mentioning the status of patent rights on devices described, if known to them.—EDITOR.]

LAPS AND LAPPING.

I sometimes wonder why we do not see more printed matter on laps and lapping, especially on rotary laps, how to charge them, and their construction. Some time ago I spoke to a very competent tool-maker who was a fellow workman in the tool-room, in regard to laps, and when I mentioned a rotary lap he wouldn't believe that accurate work could be done on such a contrivance without jabbing the corners into the lap or spoiling the edges of the work; and he also stated that he had not seen any, and had been employed in some of the best shops in the country. Well, he had a knife-edge square

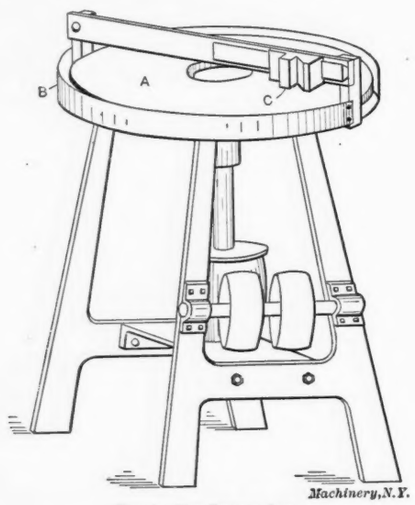


Fig. 1. The Rotary Lap.

that he had lapped on a hand lap, and I had a knife-edge square that I had lapped on a rotary lap, and we found that one was as accurate as the other.

In a small shop where I learned how to use laps, we had a rotary and a hand lap. The rotary was 24 inches in diameter, and the speed about 300 revolutions per minute. The hand lap was about 18 by 20 inches. The engraving, Fig. 1, will give a clear idea as to the construction of the rotary lap. I have found that some men who have used laps have an idea that they should be made with grooves and checks, which I think are fallacies, for I have proved to my own satisfaction that they are not essential for keeping the surfaces from filling with "bird's-eyes." Again, I have noticed that some men think that if the lap has a true, flat surface, any one can produce true work, but such is not the case; it requires considerable skill, and that skill can be acquired only by trying it yourself. Many machine operations can be shown to another person and the principle grasped readily, but not so with lapping. I know that on many occasions I had the boss show me how he did the lapping, and yet, when I went at it, I could see that there was something that I had to feel and experience for myself. The boss used to say, "You must get in touch with your work." A great deal of skill is required in lapping thin pieces, small straight-edges or long narrow bars. It is possible, and requires no skill at all, to lap a thin piece of steel, convex or concave, by using a little more pressure in one place than another, and if the surface of the lap is not kept sharp it will soon heat and warp the work out of true. I have used soda water, but find that kerosene and gasoline used together give the best results; the hand lap I always used dry. Keeping the surface of the rotary lap straight and true is very important and requires good judgment in using it. The outer edge runs so much faster than the inside that it is obvious that if it is used too much, either in the middle, inside, or outside, hollow places will be worn in the surface, so that it is a good plan to use the lap all over and try the surface frequently with a straight-edge, favoring the high places when using it.

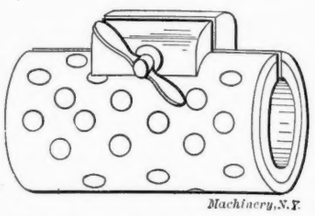


Fig. 2. Lap for Cylindrical Work.

The rotary lap is charged by sprinkling carborundum over the surface when not in motion, and then pressing it in by rubbing with a piece of round iron held in both hands. An old pepper box with a perforated top is just the thing to use for sprinkling the carborundum. The lap I used was made of an ordinary cast iron disk *A* (Fig. 1) with ribs on the bottom and anchor grooves on the top. It is also provided with a hub and a shaft. The end of the shaft supports the whole weight of the lap and runs on a hardened convex disk. A coating of lead is cast over the surface of the lap, and then hammered to make it compact. A galvanized iron pan *B* is provided, the edges of which project above the surface of the lap to prevent the liquid, or whatever is used, from flying off, and onto everything around. Another handy device on this lap is a bar which is provided with ways and a sliding head *C* which can be pushed from the outer edge to the center of the lap. The bar is fastened to lugs which project on opposite sides of the frame, and can readily be removed when not in use. The bar is also provided with adjusting screws to set it parallel with the surface of the lap or to set the sliding head square with the surface. The sliding head has a square corner and an angle groove which can be used for lapping the ends of round or square pieces. I faced the disk by belting it to the slowest speed of the drill press. A piece of self-hardening steel, for a tool, was clamped on the sliding head, and a threaded ¼-inch rod fastened so that it would work through a stationary nut, and by turning the screw slowly, the tool was fed across the disk.

The engraving Fig. 2 shows how I usually make a lap for cylindrical work in the lathe. A piece of wrought iron pipe about 2 inches long, with a number of 5/16-inch holes drilled through will answer the purpose. Face one end of the pipe so that it will stand level on a surface plate; wrap a piece of heavy paper around the outside, using rubber bands to hold it on, then form a square with pasteboard and clamp that on any side of the pipe so that several of the holes open into it; secure a mandrel the same size as the piece to be lapped, twist a piece of string in a spiral around the mandrel, insert it in the center of the pipe, and we are ready to pour the molten lead in. When cool, drive out the mandrel and proceed to drill and tap a hole for a thumb-screw in the center of the lug; then slit one side through the center of the lug with a hack saw, and file off all sharp edges and burrs so that it will not injure the hands. In lapping, the faster the lap is drawn back and forth over the work the more nearly

straight it will be, and as the lap wears and works easy, the thumb-screw is given a slight turn to keep it in contact with the work. I always had considerable trouble with "bird's-eyes" forming on spindles when lapping them, and found that by draw-filing the eyes a little they would disappear, and the frequent scraping of the bright spots in the lap will help immensely. In using flour of emery, I found that by putting a small quantity in a bottle half filled with machine oil, I could get the coarsest emery by dipping a swab down to the bottom, or finer by shaking the bottle a little and using the oil only for finishing, as the coarser particles sink to the bottom while the finest particles are held in suspension in the oil. Taper lapping is very difficult and requires a great

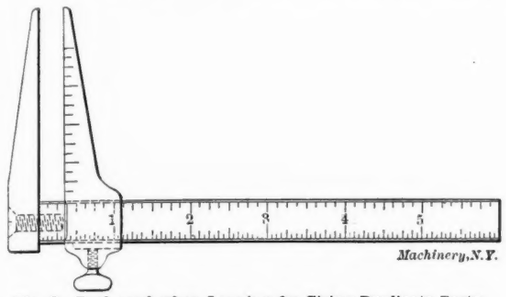


Fig. 3. Tool used when Lapping for Sizing Duplicate Parts.

deal of care. The cast iron lap must be constantly trimmed, kept straight, and the taper the same as the desired taper in the piece being lapped; it must also be kept well lubricated and not be crowded any. A very handy tool, which is shown in Fig. 3, is almost indispensable in doing work with the rotary and hand laps; it is a home-made caliper square. The taper between the hardened jaws is 0.001 inch in the whole length, and a 6-inch flexible scale is inserted in the beam. One jaw is graduated, which enables one to see how far the piece will slide up in the jaws. This caliper is not used so much for accurate measurements as for accurate sizing for parallelism or duplicating sizes.

Minneapolis, Minn. A. J. DeLille.

PATENTS AND INVENTORS.

In an article in the June issue, Mr. E. C. Smith makes some statements to which the writer permits himself to take exception. Mr. Smith seems to think that the inventor has no proprietary right to his own invention, except in as far as the government grants it to him. However, that the right of ownership of an invention exists independently of the government, cannot be questioned; the inventor owns his own invention because it is his; he may or may not be able to enforce his claims. About 1843, Henry Bessemer invented a mechanical process for making bronze powder. His finished powder cost him less than $1.50 per pound, and he sold it for $20 per pound, making over 1,300 per cent profit. He kept the process a secret for thirty-two years, and collected profits at the above rate for that time. Did he own the invention, or did he not? If he did not, who did?

Most inventions are not of such a nature that they can be kept secret, but the question of ownership does not change. Had the Bessemer process been patented, and thrown open to the public at the end of 14 years (length of English term), the users of bronze powders would have been saved expenses amounting to many hundred thousand dollars. From this instance, the enormous value to the country of inventions, the patents of which are expired, may be estimated. Other inventions just as important are thrown open to the public every year.

In my previous article published in the March issue of MACHINERY, I stated that some of the examiners were incompetent. Mr. Smith says: "To me the showing is not one of incompetency, but of exceptional merit under adverse conditions," but then in the next sentence he says: "The commissioner states that the work of some of his force is frivolous, and otherwise lacking in essential qualities." I certainly believe that the patent office staff is working under exceedingly adverse conditions, and that there is fine work being done by many good men on it, but these good men are so handicapped by the congested state of the work and surrounded by so many men who are not as competent, that the quality of the work in general is far below what it should be. The adverse conditions referred to ought to have been changed long ago.

Large companies, as a rule, do not find much complaint about the conduct in the patent office, for the reason that the present practice suits the corporations quite well. They do not object to long postponed divisions of applications, or continual dropping of old and bringing forward of new references, because the longer the delay the longer is the effective life of the patent, but these things make a great difference to the ordinary applicant. They mean a difference of loss or gain of time of several months.

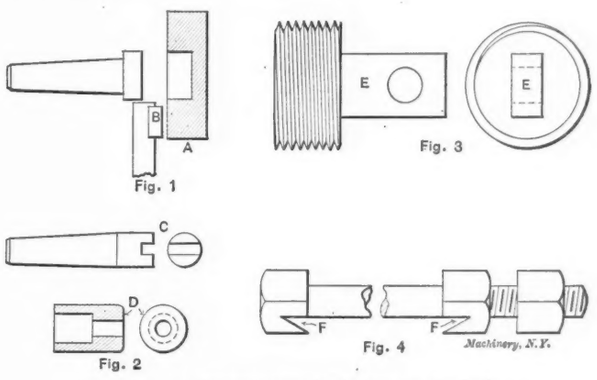
Reasons have been put forth why delay in a patent application would be advantageous to the inventor, due deliberation being preferable to undue haste, but when, as now, each application receives "due deliberation" resting in a pigeonhole in the patent office for several months, it is difficult to see what value it adds to the examiner's action in the case when he eventually reaches the application and is so pushed for time that he cannot go thoroughly into the matter, because he must hurry on to the next case. It is a mistake to suppose that a long delayed application gives the inventor a chance to further develop his invention, and fortify his case if his original claims are inadequate. The patent office rules prohibit the adding of material to a pending application.

The whole underlying cause of complaint against the patent office may be expressed in a few words—lack of money. Without sufficient help, congestion of work and delay in action is inevitable. Were it not for the delays, patentees would not find the mistakes of which complaints are now made, so unbearable. If the office were in such condition that applications would not be delayed more than two or three weeks at each action, it would not be necessary to find fault, but under the present system when actions occur at intervals of from six months to a year, there is entirely too much time wasted.

Toronto, Canada. H. Addison Johnston.

A FEW HANDY KINKS.

A number of pieces, as shown at *A*, in Fig. 1, were to be finished true all over, and, as the hole did not go clear through, an ordinary arbor could not be used, so the following scheme was devised: A piece of machine steel was turned to fit in the lathe spindle and the end made a press fit in the hole in the work. After being pressed on by the



Figs. 1 to 4. Miscellaneous Appliances for the Lathe.

tail-stock and turned up, the piece was taken off as follows: The tool was reversed in the tool-post, and a piece of lead placed between the back of the work and the tool, as at *B*, and the lathe started up. The heat generated by the friction of the lead against the iron caused the latter to expand and drop off in a very short time without marring the work in the least.

The method described in the January issue of MACHINERY for holding a reamer, calls to mind a handy device for a tap-holder. A piece of machine steel is fitted to the tail spindle and has a slot cut through end *C*, Fig. 2, the width of the tap's square. The piece *D* of cast iron is bored at one end a press fit for the end *C*, and the other end is a loose fit for

the tap's shank. This device prevents the tap from turning, and keeps it in line with the hole, even if the tail-stock is not kept up tight against it.

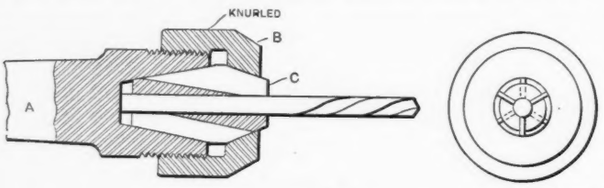
In setting a taper attachment it is very hard to get it exactly right and to get the work perfect. It is a good idea to move the tail-stock over a very small amount, and the screws make a very fine adjustment. If a thin collar is shrunk on the front tail-stock screw and then graduated, it makes a handy micrometer for setting the tail-stock accurately.

Some time ago we had several awkward and heavy jigs to fit to the lathe spindle and in order to make them a good fit without relying on calipers, we laid a face-plate on a block and filled the hole with babbitt, having the flat bar of iron *E*, Fig. 3, in the center to turn it out by. In this way a very satisfactory templet was made.

A stop for the lathe cross-slide can be quickly made of a bolt, and nut with the thread drilled out, by sawing a piece out of the face of each as shown at *F*, Fig. 4. VIM.

A SPECIAL DRILL CHUCK.

The chuck shown in the engraving is not difficult to make and is useful where there is a great deal of drilling to do with drills of one size. It consists of a taper shank *A* having a fine thread on the outside of the large end, and a taper hole bored in the end as shown. The jaws *C* consist of a piece of steel, one end of which is tapered to fit the hole in *A*, and the other end to fit the taper in knurled clamping nut *B*. A

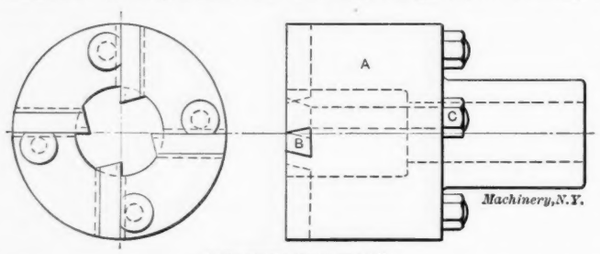


Simple Form of Drill Chuck.

hole is drilled in the jaws *C* the size of the drill the chuck is made for, and from each end three grooves are milled completely splitting the ends of piece *C* into three parts, but the cuts run back on an angle so that metal is left to hold the parts together. The clamping is done by the knurled nut *B*. By making extra jaws *C*, the chuck can be made to take drills of different sizes. W. ALTON.

ADJUSTABLE HOLLOW MILL.

The accompanying engraving shows an adjustable hollow mill which has proved very efficient. This tool consists of a machine steel body *A*, in which four dove-tail slots are cut, into which the four cutters *B* are inserted. These cutters are clamped in place by the taper-headed bolts *C*, which have one side flattened, as shown in the engraving, to permit a rigid



Adjustable Hollow Mill.

hold on the inserted cutter. This tool has stood the test of hard usage very well. It has proved to be practically as rigid as a solid hollow mill, and at the same time, it can be quickly adjusted for different sizes. W. ALTON.

[It will be noticed that the principle of the design of this tool is practically the same as the one employed in the adjustable hollow mills made by the Brown & Sharpe Mfg. Co. In these latter tools, however, there is no dove-tail slot, but the blade is simply bound tightly against the back of a square slot by means of the taper side of the binding bolt, which engages an angular groove in the inserted blade. The hollow mill shown by our correspondent is somewhat more expensive to make, but undoubtedly it permits a firmer grip on the blade, and holds it in position very rigidly.—EDITOR.]

SHERARDIZING OR DRY GALVANIZING.

In the November, 1904, December, 1905, and February, 1908, issues of MACHINERY articles were published descriptive of the dry galvanizing process, discovered and developed by Mr. Sherard Cowper-Coles, London, England. The United States rights for this process have been acquired by the United States Sherardizing Co., New Castle, Pa., and the Globe Machine & Stamping Co., Cleveland, O., has acquired the shop rights. It is to the latter concern that we are indebted for the following description of the process, prepared by Mr. J. Everett Thompson, formerly of the American Steel & Wire Co., and the Jones & Laughlin Steel Co. Mr. Thompson is making a special study of the new process.

The "sherardizing" process of dry galvanizing is applicable not only in all cases where hot or cold galvanizing can be used, but in numberless other cases where they cannot. Briefly, the process consists in packing the articles to be covered with the zinc coating into a closed drum, box or other suitable receptacle in contact with the ordinary zinc dust of commerce. The receptacle is then put into an oven and gradually heated to the required temperature of about 700 degrees F. for a period of four or five hours. The drum is then withdrawn and allowed to cool down to a temperature convenient for handling, when its contents are dumped upon a screen, which allows the zinc dust to fall freely into the chamber below, from which it can be drawn for use again.

The articles are found to be evenly coated with pure zinc, this constituting the entire process. The operation is so simple that the most ordinary class of unskilled labor can be employed without fear of securing poor results. Even the matter of gradually heating up and cooling off is automatically controlled by the fact that zinc dust is a poor conductor of heat. There can be no sudden increase of temperature, as is the case when an article is suddenly plunged into a molten bath of zinc, or the subsequent rapid cooling. Articles do not warp out of shape and even springs are found to retain their temper.

The great superiority of the sherardizing process consists in the fact that in addition to a surface coating of zinc, an infinitesimal quantity of zinc is alloyed into the iron or steel itself and forms a rust-proofing that resists corrosion. This is a very important advantage over the hot galvanizing process. With the latter, in case of a pin-hole, scratch or other abrasion of the coating, a rusting action is set up upon exposure to the elements which in time causes the galvanized coating to peel off. In the case of the sherardizing process, a pin-hole would probably penetrate only to the alloy coating, and no rusting action would take place, but even if the abrasion penetrated through the alloy there could be no possibility of rusting between the zinc coating and the steel.

In many cases, the articles need no special cleaning before being sherardized, but when they do, they are cleaned as is done in ordinary galvanizing. Articles coated with grease or oil take as good, if not better, coating of zinc than those which are free from it.

The extreme evenness of the zinc coating, no matter how thickly it may be applied, preserves sharpness of outline. Screw threads, stamped letters, graduated lines on steel scales are preserved sharp in outline, and if a slight clearance has been given a sherardized nut, it will run onto a sherardized screw as easily and smoothly as if there were no coating; thus no recutting is required. The coating is so smooth and even on parts of fine machinery that they can be assembled after being subjected to the process without requiring filing or fitting.

Numerous other advantages could be mentioned. Articles coated by the process when buffed may be substituted for brass or nickel plated goods; they will retain their color and brightness and can be cleaned more readily than nickel. Since the coating is in the surface and not on it, it does not peel off as the plating is prone to do. It is claimed that sherardized plumbers' fittings are unequaled for finish and durability. Sherardized marine fittings rank next to solid copper and brass in ability to withstand corrosion. A sherardized steel propeller shaft is stronger and will withstand corrosion as well as one made of costly phosphor bronze. Chains treated have remained in sea water continually for nine months without showing any evidence of corrosion.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

HOW ARE HACK-SAW BLADES HARDENED?

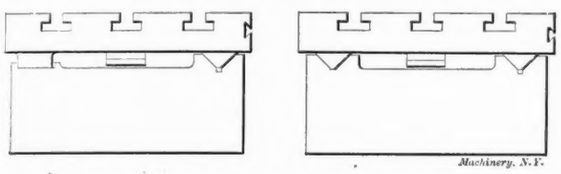
H. G.—How are hack-saw blades hardened in large quantities? Working them one by one as I do now takes too long.

A.—We are unable to give you the desired information. The manufacture of hack-saw blades has been kept pretty well under cover, but inasmuch as there is a number of manufacturers now engaged in making hack-saw blades, it cannot be regarded strictly as a trade secret. We would be pleased to receive a good contribution on the subject from one of our readers.

BEARINGS FOR PLANER PLATENS.

H. U.—What are the advantages or disadvantages in large planers of 8-foot size and larger, having the platen made with two vees, as compared with platens having one vee and one flat way? Which, in general, is considered the preferable construction?

A.—Small planers are built with two vees, not for the reason that two vees are necessarily required for guiding the platen, but largely, we believe, because the weight of a small platen might not be sufficient to hold it down into the vee way when



planing on the extreme edge of a piece located over the flat way. The side and vertical pressures of the tool might be sufficient to lift the opposite side of the platen slightly and push it over, thus causing defective work, whereas if a vee is under the side of the platen where the tool is working, the side pressure effect would be overcome by the vertical pressure, tending to hold the platen in place. On large planers this danger disappears because of the great weight of the platen relative to the pressure of cut and weight of work. The fact that a platen with one vee way and one flat way is easier fitted, and that the combination wears better, naturally causes it to be regarded by many competent designers as the preferable construction for large planers where it can be safely used. We would like the opinions of our readers on the subject.

A PROBLEM IN TRIGONOMETRY.

S. S. Y.—In the accompanying sketch (see Fig. 1) is shown the cross section of a trolley wire, the dimensions and angles being given as shown. I would like to know how to find the dimensions indicated by x and y.

A.—Referring to Fig. 2, we will first solve a problem of this kind having a general application, and will then apply the

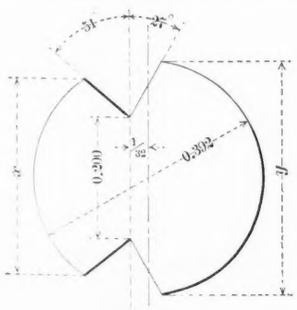


Fig. 1.

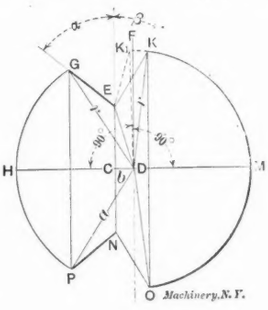


Fig. 2.

formulas we find to the specific case in question. It will be found upon examination, that it is not possible to give a simple general formula, but that it is much easier to solve this problem by taking a step at a time, and finding various dimensions and angles, as we go along. Referring to Fig. 2, it is apparent that to find the distances GP and KO, which are the required distances x and y in Fig. 1, we must find the angles GDH and KDM. When these angles are found, the distances GP and KO are simply the chords corresponding to the angles GDP and KDO, of which the angles GDH and KDM are one-half, respectively. Any handbook will give us the formula for finding the chord when the center angle is given, so that our problem resolves itself into finding this angle.

Let a = the given length EN,

b = the given distance CD, and

r = the radius of the wire = one-half the given diameter.

We have then

$$\tan CED = \frac{b}{\frac{1}{2}a}$$

From this we can find the angle CED, which we will now consider as known. Angle $EDF = CED$, and is therefore also known. Further,

$$ED = \sqrt{\left(\frac{a}{2}\right)^2 + b^2}$$

and angle

$$GED = (180^\circ - \alpha) + CED$$

α, being one of our given angles.

We have now the triangle GED, in which we know two sides ED and GD and the angle GED. The side $GD = r$. We then have

$$\sin EGD = \frac{ED \sin GED}{r}$$

and when we have found the value of angle EGD from this formula, we can find angle GDE from

$$GDE = 180^\circ - (GED + EGD).$$

Furthermore, $GDE + EDF = GDF$, and $GDH = 90^\circ - GDF$. Knowing the angle GDH, we have

$$x = 2r \sin GDH.$$

Applying the same reasoning on the other side of line ED, in order to find the angle KDM, we have:

$$KED = 180^\circ - (\beta + CED)$$

$$\sin EKD = \frac{ED \sin KED}{r}$$

$$EDK = 180^\circ - (EKD + KED)$$

$$FDK = EDK - EDF$$

$$KDM = 90^\circ - FDK$$

$$y = 2r \sin KDM.$$

However, it may happen that the point K does not fall on the right-hand side of the line DF, as shown, but may fall as K_1. In principle, this makes no difference. Only, in calculating the length of the line KO, we use the angle K_1DH instead of the angle KDM. Our numerical calculations will always indicate on which side of the line FD the point K falls, by making angle FDK negative, if K falls as K_1, so that there is no possibility of mistake.

If we apply the formulas, as given above, directly to the case in Fig. 1, our calculations will be as follows:

$$\tan CED = \frac{0.03125}{0.1} = 0.3125; \quad CED = 17^\circ 21' = EDF.$$

$$ED = \sqrt{0.1^2 + 0.03125^2} = 0.1048.$$

$$GED = (180^\circ - 51^\circ) + 17^\circ 21' = 146^\circ 21'.$$

$$\sin EGD = \frac{0.1048 \sin 146^\circ 21'}{0.196} = 0.29629.$$

$$EGD = 17^\circ 14'.$$

$$GDE = 180^\circ - (146^\circ 21' + 17^\circ 14') = 16^\circ 25'.$$

$16^\circ 25' + 17^\circ 21' = 33^\circ 46' = GDF$; $90^\circ - 33^\circ 46' = 56^\circ 14' = GHD$.

$$x = 0.392 \sin 56^\circ 14' = 0.3259.$$

To find y, we have

$$KED = 180^\circ - (27 + 17^\circ 21') = 135^\circ 39'.$$

$$\sin EKD = \frac{0.1048 \sin 135^\circ 39'}{0.196} = 0.37378.$$

$$EKD = 21^\circ 57'.$$

$$EDK = 180^\circ - (135^\circ 39' + 21^\circ 57') = 22^\circ 24'.$$

$22^\circ 24' - 17^\circ 21' = 5^\circ 3' = FDK$; $90^\circ - 5^\circ 3' = 84^\circ 57' = KDM$.

$$y = 0.392 \sin 84^\circ 57' = 0.3905.$$

The problem, while requiring some time for working out, is very simple, involving as it does only the first principles of trigonometry.

MODERN GERMAN MILLING MACHINES.

OSKAR KYLIN.*

The accompanying half-tone engravings, Figs. 1 and 2, show two milling machines built by the Wanderer Fahrradwerke, Schoenau bei Chemnitz, Germany. The machines shown represent the highest development of this firm's milling machines, being the last ones of the company's line of machine tools that have been placed on the market. The Wanderer Fahrradwerke originally engaged only in the bicycle business, but, when the demand for accurately made machine tools increased in Germany during the last decade, the company added a department for machine tool manufacture.

Fig. 1 shows what is designated as the Wanderer No. 3 vertical milling machine. An inspection of the engraving will easily convince the careful observer that proper attention has been paid to the matter of giving the machine the rigidity and stiffness required for accurate work of the heavy character for which the machine is intended. It is also in evidence that nothing has been left undone in the way of providing for easy means of adjustment and handiness of operation, the machine possessing practically the same features as the last model of the Brown & Sharpe Company's vertical milling machine.

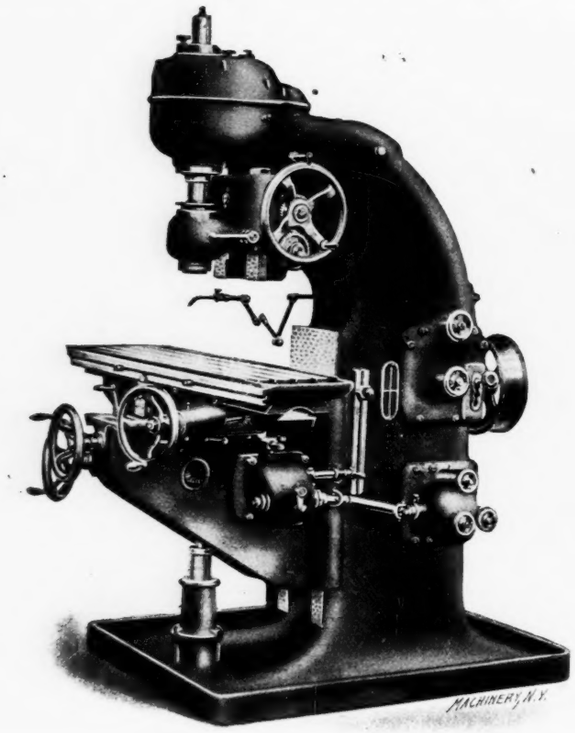


Fig. 1. Wanderer Fahrradwerke No. 3 Vertical Milling Machine.

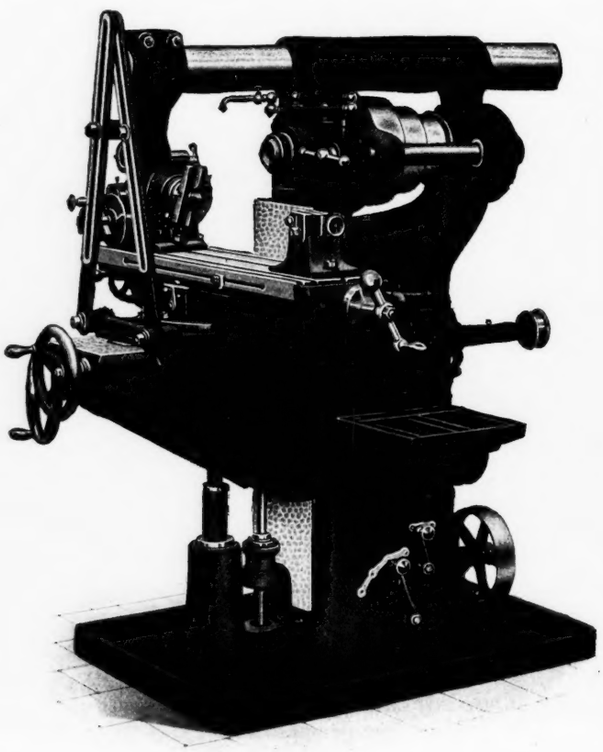


Fig. 2. Universal Milling Machine built by the Wanderer Fahrradwerke.

The machine is driven from a constant-speed counter-shaft through a single pulley drive, from which all motions of the machine are obtained. By means of a gear box, 16 different speeds are obtainable for the spindle of the machine, varying from 17 to 352 revolutions per minute. The vertical adjustment of the spindle is operated by a hand-wheel provided with a dial graduated to indicate motions of the spindle of 1/20 millimeter (0.002 inch). The table of the milling machine is provided with automatic feed in three directions—vertical, longitudinal, and cross-feed. The longitudinal feed motion is driven by a spiral gear, engaging with a rack on the under side of the table. The mechanisms for engaging and disengaging all the automatic feeds are located on the side of the knee, and may be conveniently reached by the operator, the engaging and disengaging being accomplished by the turning of the respective cranks provided. All the different table feeds can be stopped automatically by dogs provided, easily adjustable in suitable slots. Twelve different feeds are obtainable, the feed changing device consisting of a gear box placed on the column of the machine as shown. The mechanism is operated by small hand-wheels, the machine being provided with proper scales, giving the table feed per revolution of spindle, for different settings of the hand-wheels. The amount of variation obtainable of the feed per revolution of spindle varies between the limits 0.036 and 7.2 millimeters (0.0014 to 0.29 inch). In order to prevent accidental motion of the table during working, all the hubs of the controlling hand-wheels are provided with clutch devices which enable them to be disengaged as soon as the different adjustments have been made. Suitable covers have been provided over all gearing, and proper care has been taken to prevent the chips from coming into the oiling devices and other vital parts of the machine. The speed change mechanism is placed in an oil and dust-proof cover.

The total horizontal working surface of the machine is 44 × 12 inches, the longitudinal feed of the table is 44 inches, and the cross-feed 12½ inches. The vertical motion of the spindle is 4 inches, and the total weight of the machine is 4,200 pounds.

In the half-tone, Fig. 2, the universal milling machine built by the Wanderer Fahrradwerke is illustrated. This machine is known as the Wanderer No. 2 universal milling machine. It is apparent from an inspection of the illustration that, in this machine also, proper attention has been paid to the question of the stiffness and rigidity required in order to turn out accurate work under severe working conditions. This machine is driven by a three-step cone pulley, provided with back gears, the three steps of the pulley being 6, 8, and 10 inches in diameter, respectively.

The automatic feed for the work table provides for 16 changes, varying from 0.1 to 5 millimeters (0.004 to 0.20 inch) per revolution of spindle. The gear box for the feed changes is located inside of the column, and is operated by levers, plainly shown in the illustration, the motion for the gear box mechanism being obtained through a belt-driven pulley.

The total table surface is 34 × 8 inches; the longitudinal motion of the table, 20½ inches; the cross-feed, 10 inches; and the vertical adjustment 17½ inches. The weight of this machine is 2,200 pounds.

* Foreign Traveling Representative of MACHINERY.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

KEARNEY & TRECKER UNIVERSAL MILLING MACHINE.

The accompanying illustrations show a new improved milling machine, brought out by the Kearney & Trecker Co., Milwaukee, Wis., and known as No. 3 B Milwaukee universal milling machine. Several interesting features have been introduced in this design, which are not generally found in machines of this type, and while following the general style of previous construction, the design is original and highly interesting in many respects.

Figs. 1 and 2 show two general views of the machine, one taken from the front and one from the side. Fig. 3 shows a rear view of the machine, and gives a clear idea of the manner in which the feed box and pulley bracket are attached, as well as of the arrangement of the levers for the speed and feed changing device. As seen from these illustrations, the tool is a constant drive geared machine, of the advantages of which the firm manufacturing these machines is fully convinced. Tests undertaken have caused the firm to abandon the cone pulley driven milling machines entirely.

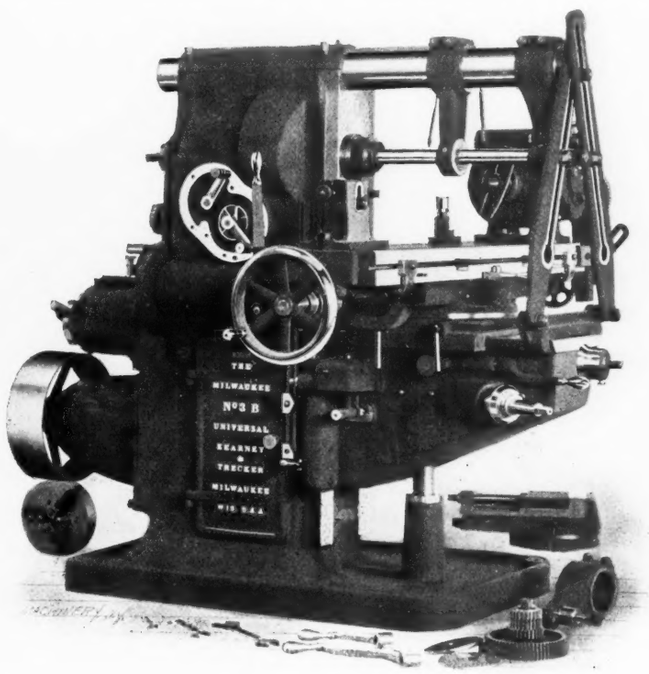


Fig. 1. Front View of Kearney & Trecker No. 3B Universal Milling Machine.

Spindle Drive and Speed Changing Device.

The driving pulley is mounted on a shaft carrying on its inner end a pinion which engages with a larger gear, whereby a speed reduction of about 3½ to 1 is accomplished, the pulley itself running at 350 R. P. M. This larger gear runs idle on its shaft and is free to move endwise thereon. On one side of the gear is placed a hardened steel clutch, and on the same shaft is also another gear of the same size, also carrying a clutch. This last gear, in turn, meshes with a gear directly above it on one of the shafts in the gear box, which, in turn, drives the feed and also meshes with pinion *V*, shown in the line engraving, Fig. 4.

The first large gear mentioned, the one which engages with the pinion on the pulley shaft, is moved by the starting lever seen extending upward directly at the right of the head in Fig. 3, until the clutches referred to become engaged, thus starting and stopping the machine without the use of friction clutches. This is permissible by reason of the fact that the clutch referred to always revolves at a constant speed, and this speed is low enough not to produce any noticeable shock, regardless of the speed at which the milling machine spindle itself may be running. The pinion *V*, in Fig. 4, drives the shaft *B*, to which is keyed pinion *W*, which, in turn, drives the idle gear *D*. This idler is carried by the swinging bracket *X*, which has gear teeth cut on its outside at *A*. These gear teeth mesh with a long-faced pinion controlled by the upper index lever shown to the right of the gear box in Fig. 3. The line engraving, Fig. 4, in order to show the construction, shows the segment *X* dropped down further than it actually would come, because in reality it swings in such a way that the pinion *D* engages with the various steps on the cone gear *E*. The endwise location of the swinging bracket *X* is controlled by the handle attached to the spindle speed dial, shown in Fig. 5. This handle operates the lower gear and rack shown in the same illustration, a projecting extension from the rack engaging with the slot *C* in the bracket *X*. The spindle speed plate in Fig. 5 shows 18 speeds, varying by increments of approximately 20 per cent from 13 to 320 R. P. M.

Attached to and revolving with the cone *E* in Fig. 4 is the pinion *O*, which engages the gear *N*. This latter gear turns idle on the spindle of the machine and carries a pin *M*. The sleeve gear *F* on the spindle has two gears *I* and *K*, which engage alternately with gears *J* and *L* on the cone *E*, this sleeve being keyed to the spindle *G*. The gear *I*, when moved to the right, thereby bringing *K* out of engagement with *L*, engages the gear *N* through the pin *M*. It will be easily seen that by this arrangement three speeds are obtained directly at the spindle, which, multiplied by the six speeds obtained by the cone *E* and idler *D*, gives 18 speeds in all.

The speed plate in Fig. 5 has three concentric rows of speeds, the inner row being the slowest and the outer the fastest speeds. The inner one of these sets of speeds is obtained when the lever at the left in Fig. 5 is at the position shown in Fig. 1. This lever operates the upper gear and rack in the view to the right in Fig. 5, and a projection on the rack engages with the groove *H* on sleeve *F*, Fig. 4, so that this sleeve can be set easily to any one of the three positions which the lever can occupy. The hand-wheel *U*, in Fig. 4, serves the purpose of turning the spindle by hand, when necessary, or to slightly move the gears, when this is required, in order to bring them into engagement. It will be noticed that the spindle runs in taper bearings, the wear being taken up by the sliding of the cone-shaped bearing *R*, which is accomplished by means of a collar *S*, threaded on the spindle. When the collar has been properly adjusted, it is locked in position by the screw *T*.

Lubrication Arrangement.

Connected with the large gear, driven by the pulley shaft pinion previously mentioned, is a pump of simple construction, consisting of two spur gears running together in a suitable case. This pump raises the oil from the reservoir, shown at the right-hand side at the bottom of the column of the machine in Fig. 2. The oil is raised to the top of the machine above the gears on spindle *G*. Here is a perforated pipe extending from end to end of the frame and delivering oil into the pockets *P* and *Q*, and through the numerous openings in the pipe to the gears between the bearings. The oil is thrown by the gears from one to the other, and falls downward by gravity, the shafts being located approximately in a vertical plane. It also works its way downward by reason of overflow from the pockets *P* and *Q*, cascading into the various pockets and bearings in continuous streams, flowing over the mechanism without interruption. Provision is also made so that a portion of this falling oil finds its way into the feed box at the back end of the machine, lubricating all the shafts and gears contained therein. It also finds its way in a continuous stream through the pulley bracket to the bearing next

to the pulley. The oil is returned through the bottom of the pulley bracket, most clearly shown in Figs. 1 and 2, to the reservoir which extends from the one side of the machine to the other. From this it is again pumped to the discharge pipe above the spindle to continue its circuitous route.

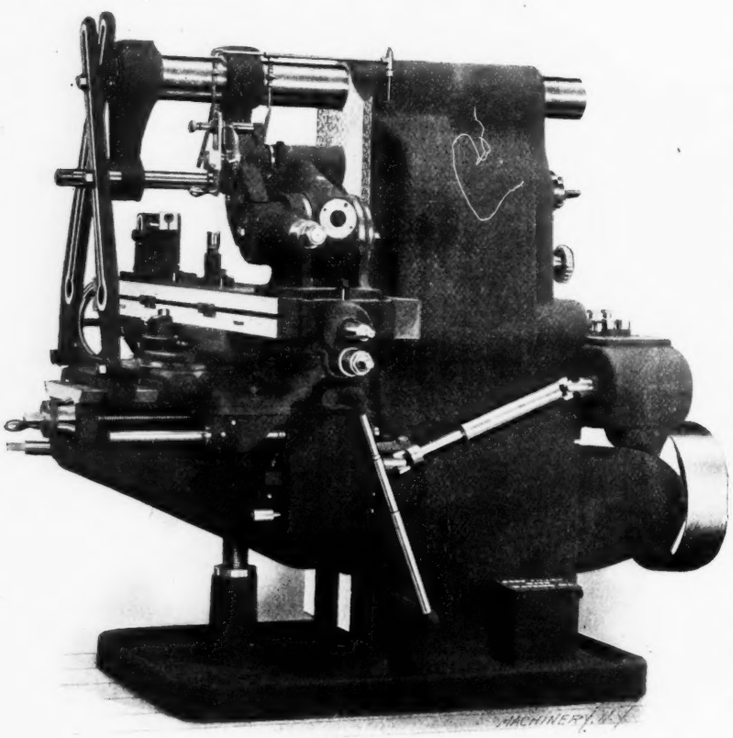


Fig. 2. Side View of Milwaukee Universal Milling Machine.

There is another pump for the oil used for lubricating the cutters, this pump being located in the closet in the inside of the machine frame, behind the door shown in Fig. 1. This pump runs only when the spindle runs, while the pump for lubricating the gears and bearings runs continuously, so that the pulley shaft is flooded with oil, regardless of whether the machine is running or not. The opening covered by the front door, on which the name of the machine and the makers is cast, is not as large as the door would indicate, as there is a wall back of this door, extending from the bottom to about the height of the door knob for the purpose of forming a reservoir for the lubricant used for cooling and lubricating the milling cutters. The pump for this lubrication has a relief and pressure regulating valve, so that the pressure of oil can be regulated to any desired amount. From this pump a pipe extends upward in the interior of the machine, emerging near the top of the frame, as shown in Fig. 2. To the top end of this pipe is attached a swinging connection, and from this a horizontal pipe connection, branching out and connecting with two pieces of flexible oil tubing, carries the oil to the cutters. This arrangement is the standard equipment, which, of course can readily be varied to suit any special case, as many of these flexible tubes being used as found necessary.

One of the great troubles in connection with flooding the cutters and the table with oil has hitherto been the trouble in connection with returning it to the reservoir, the means provided never being adequate. Referring to Fig. 6, which shows part of the table and the swivel carriage of the machine, it will be noted that an oil pocket is provided at the end of the table, there being another pocket at the other end. These pockets are partitioned half way down by the screen shown in the illustration. Connected with the pockets are channels along the sides of the table, which are also divided half way down into two sections by a strip of steel, shown extending up from the groove at the end of the table. The oil falling on the table runs into the T-slots and into the grooves along the edges of the table, which carry the oil to the pockets at one or both ends, where it is strained by the screen mentioned, and then flows to the center of the table through the same grooves along the edges, but under the strip of steel referred to. From the center of the table the oil escapes through a hole into a telescopic slide shown at the extreme top of the swivel carriage in Fig. 6. The parts are so proportioned that the hole in the table will never run beyond the swivel carriage. An opening in the side of the top slide mentioned connects with the long opening in the swivel carriage. This opening terminates in a hole in the bottom of the swivel carriage, which registers with a circular groove in the saddle, and this circular groove, in turn, connects with the swivel joint of the telescopic oil tube, shown at the side of the knee and column in Fig. 2, the oil flowing through this tube to the reservoir, to be again pumped to the cutters. The strip of steel shown lying across the table in Fig. 6 is used to replace the screen when milling cast iron, in order to prevent the dust and chips from this material from finding their way into the channels leading downward to the reservoir.

Feed Mechanism.

The feed change mechanism is contained in the change gear box at the rear of the machine, and the feed changes are effected through gearing quite similar to that shown by the line engraving, Fig. 4, for the spindle drive, these gears also running in oil, as before mentioned. The index plate, giving the amount of feed, shows this in the rates of feed in inches per minute. Twelve feed changes are obtainable, varying from ½ inch to 16 inches per minute, or from about 0.0015 inch per turn of spindle for small cutters, to a little over one inch per turn for finishing cuts with large cutters. From the feed box the power is transmitted directly to the knee, through the universal joint telescopic shaft, shown in Fig. 2. A spur gear reverse is provided at the side of the knee, operated by the push handle, shown in Fig. 2, near the lower edge of the gear box on the side of the knee. This handle slides a clutch between two spur gears running in opposite directions. The feed

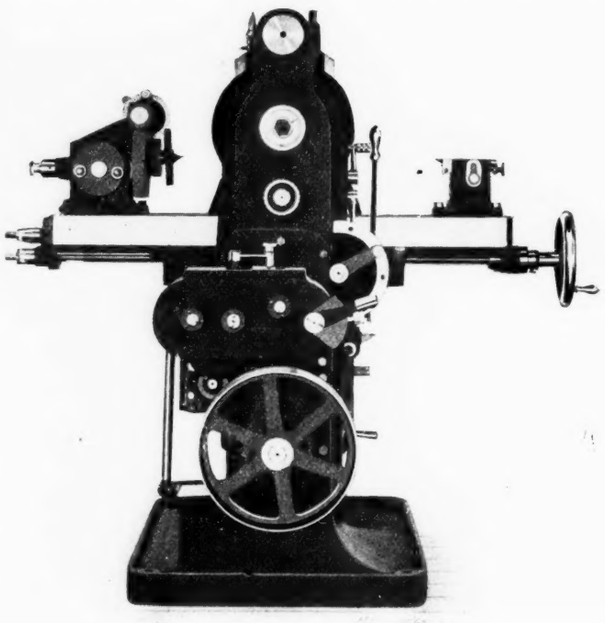


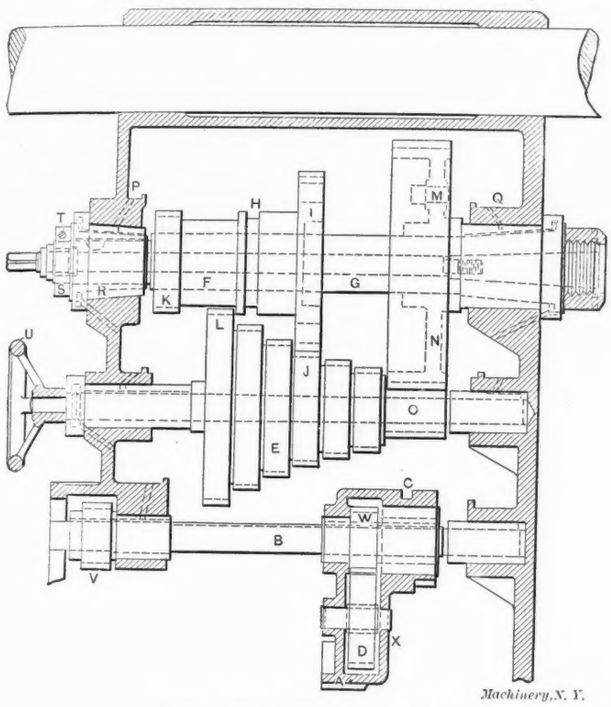
Fig. 3. Rear View of the Milling Machine.

operating handles are shown in Fig. 1. The machine is provided with longitudinal, vertical, and cross feed, for the table, and means are provided to prevent the accidental engagement of more than one of these feeds at a time, and also to make it clear to the operator which feed he is about to use,

without experiment. For each of the three feeds, there is a hole drilled in the side of the knee, below which is stamped the feed that will be engaged if the plunger shown on the side of the knee, in Fig. 1, below and somewhat to the right of the hand-wheel, is engaged in either of the three holes. The lever on which this plunger is mounted is connected in such a manner with the remainder of the mechanism that either of the two feeds for which the plunger is not set, becomes inoperative, until the plunger is changed to another hole. Adjustable trip blocks are provided to trip the feed at any desired point, and fixed trips are provided at the end of the stroke of all the feeds.

General Features of Design.

Ball bearing thrust collars are provided for all feed-screws. A second ball bearing on the cross feed screw, inside of the knee, takes the thrust in the opposite direction. The handles shown on the side of the saddle, in Fig. 1, pointing downward,



Machinery, N. Y.

Fig. 4. Section through Speed Gear Box.

are used for clamping the saddle to the knee. To prevent the knee from becoming distorted, on account of this clamping, or from distortion produced by strains from the action of the cutters on the work, it is cast without a hole through the top, this construction being a continuation of the Kearney & Trecker Company's practice, having been inaugurated in the first cone pulley machine built by the company, and regarded as a very important feature in this type of machine. It not only renders the machine more rigid, and less liable to distortion under strain, but also permits greater cross range and

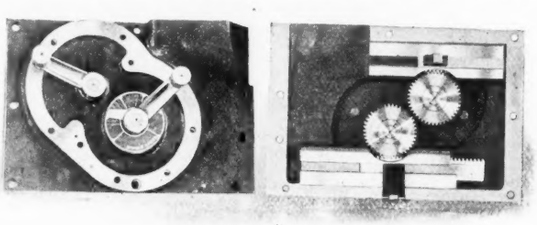


Fig. 5. Speed Change Lever Mechanism.

wider tables on universal machines. This machine has a table 14 inches wide, with a cross range of 12 inches, and is capable of being swiveled to an angle of 52 degrees, utilizing the full table travel. It can also be swiveled through an angle of 360 degrees, the table feed remaining operative at any angle.

The arm braces are so constructed that they can be removed from the machine without taking off any nuts. They are very simple in construction, and their efficiency is much enhanced by the bolt at the top which ties the two braces together.

Dividing Head.

The universal dividing head claims some attention. This is shown in Fig. 7. It will be seen from this engraving that the worm-wheel is on the front end of the spindle, which

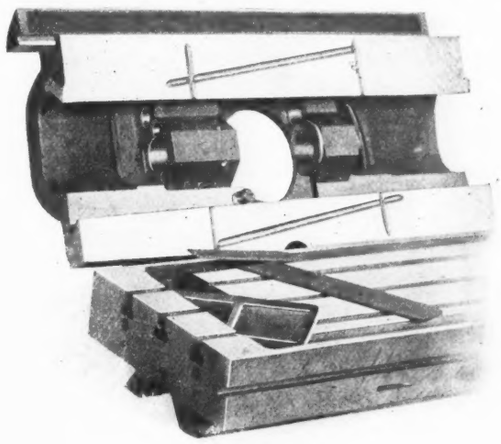


Fig. 6. Oil Return Arrangement in Table and Swivel Carriage.

makes it possible to make it very much larger in diameter than if it were placed in the interior of the head, where it could be no larger than the opening through which the spindle is introduced, or at most, no larger than the distance between the housings. A large diameter worm-wheel is clearly conducive to accuracy, other things being equal, and the placing of the index plate with the index lever directly on the worm shaft eliminates the inaccuracy that may arise on account of indexing through gearing, which is necessary when the index plate is placed on a secondary shaft. In order to prevent the spindle from becoming exceedingly high when turned to a ver-

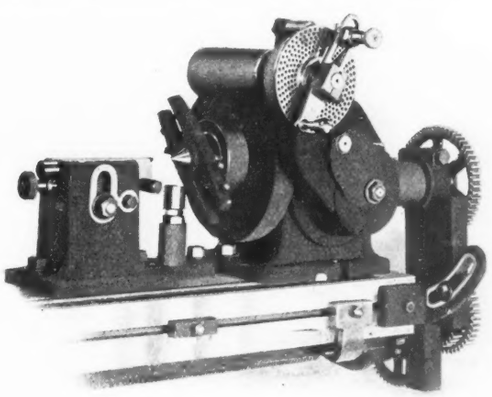


Fig. 7. Dividing Head.

tical position, the center line of the spindle is considerably above the axis of the center block, so that the end of the spindle, when it swings in an arc around this axis, reaches the highest position before it stands in a vertical direction, and commences to move downward before reaching the vertical position. On account of the worm-wheel being large in diameter, larger work may be carried out on this machine than could otherwise be considered, and for this reason the driving mechanism and the change gears connecting the worm shaft with the table feed-screw must of necessity be strong enough for heavy work, and the method of carrying the change gears must be sufficiently rigid to withstand heavy duty. The swinging bracket in connection with the semi-circular bracket clamped to the end of the table, as shown in Fig. 7, fills these requirements. In order to facilitate the setting of the universal head to any angle, in relation to the spindle of the machine, and make it fully universal, it is arranged to interchange with the circular base on the milling machine vise.

The longitudinal table feed of the machine is 36 inches, the cross feed, as already mentioned, is 12 inches, and the vertical feed 19 inches. The driving pulley is 16 inches in diameter for a 5-inch belt, and runs at 350 R. P. M.

NEWTON CYLINDER AND VALVE CHAMBER BORING MACHINE.

The accompanying half-tone illustration, Fig. 1, shows a new machine brought out by the Newton Machine Tool Works, Inc., Philadelphia, Pa. This machine is especially designed for the boring of the cylinder and piston valve chamber of simple and compound engines, at one setting. The machine shown in the illustration was built specially for a locomotive building company, where one machine was used for the valve chamber and another for the cylinders, and in this the vertical travel of the table is only 8 inches. The regular type of machine, however, is provided with longer ways for the knee which carries the work table, so that in this case the work table has a vertical movement of 36 inches, the maximum distance between the spindle and the table being 51 inches, and the minimum 15 inches. When this machine is used, work such as shown in the line engraving, Fig. 2, can be carried out to advantage. The adjustment on the machine being vertical, longitudinal, and transverse, a cylinder, after it has been planed, can be placed on parallel strips on the table, and the high pressure and low pressure cylinders and the valve chambers bored without resetting, which insures perfect alignment of the cylinders, the proper centers being maintained by the use of gages.

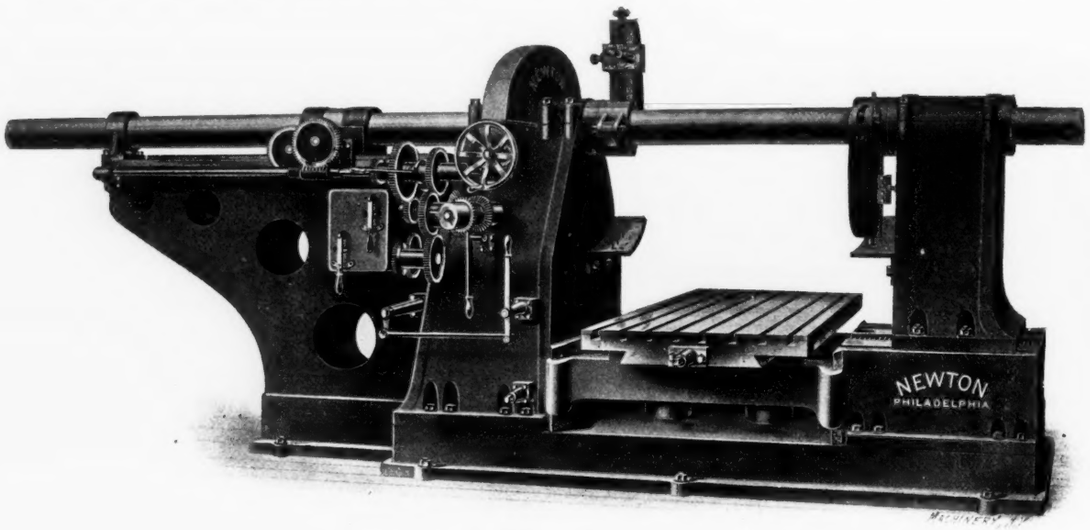


Fig. 1. Newton Cylinder and Valve Chamber Boring Machine.

Six changes of feed in either direction are supplied to the spindle through the gear box, the feeds amounting to 0.062, 0.100, 0.166, 0.333, 0.667 and 1 inch per revolution of spindle. The feed is engaged by the lever above the feed box, which when moved to the left engages the feed, and when moved to the right engages the quick traverse, both of these movements being reversed by the lever directly under the hand-wheel in the front of the machine. The quick power motion in either direction is at the rate of 10 feet per minute.

The spindle has a speed range of from 4 to 15 R.P.M., and is operated either by a four-step cone or by a 20 H.P. 3 to 1 variable speed motor, the drive being connected with the spindle through a clutch, so that the spindle can be started and stopped without stopping the motor or counter-shaft. A fly-wheel is attached to the motor to overcome the shock of the engaging and disengaging of the clutch. The spindle is 7 inches in diameter, and provided with two splines for driving, and is ground and fitted into two sleeves, one in each bearing. The sleeve in the head bearing is used for driving the spindle through a worm and worm-gear connection. The worm-wheel is made of bronze, and the worm of steel, the mechanism being encased and running in oil. The sleeve at the foot-stock bearing is keyed to the spindle and revolves with it. Both of these sleeves are lapped in the hole for the spindle, so as to insure proper bearing, and are ground on the outside and fitted in brass bushings, a cap bearing being provided for compensation for wear.

To each of the sleeves is fitted a facing arm, as plainly shown in the illustration, Fig. 1. This arm can be engaged or disengaged without stopping the spindle motion. The arm is provided with a tool slide, having adjustment out and in for setting the proper depth of cut, while, at the same time, it has a feed in either direction on the arm by means of a small star wheel and screw. The spindle is fed forward by a carriage or trolley operated by a screw and nut, and has a continuous motion of 11 feet 8 inches, so that it can be entirely withdrawn, when removing the cylinders from the table of the machine, at one single traverse motion. The foot-stock bearing is adjustable by means of a rack and pinion, giving a minimum distance between the facing arms of 45 inches, and a maximum distance of 60 inches. The cross adjusting table is fitted with steel plates on the top, which give a steel web to the T-slots, and prevent the edges from breaking out, and at the same time the alignment of the top of the table is maintained. The table has both hand and power adjustment, and is adjustable longitudinally on the knee in order to permit bringing different lengths of cylinders centrally between the facing arms. The knee is raised and lowered by power, the vertical adjustment, however, having a fine hand adjustment as well. The hand adjustment for the table, vertically, is accomplished by a ratchet through a shaft visible in the illustration, Fig. 1, directly to the left of the knee. The knee is accurately fitted between ways on the front and back part of the bed, and is supported by four

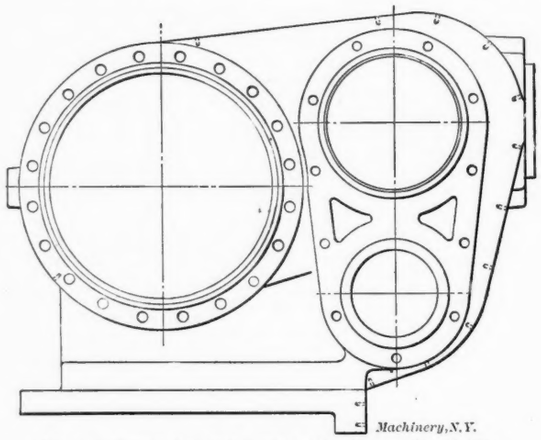


Fig. 2. Example of Work Bored in Machine at One Setting.

screws, 6 inches in diameter, which are also used for the vertical adjustment.

It is possible on this machine to bore a simple cylinder and valve chamber in five hours, and an auxiliary table can be furnished for boring inclined cylinders. This table can be swiveled to an angle of 20 degrees so that inclined cylinders may be bored without requiring additional setting.

SINGLE PULLEY GEARED-DRIVE ROCKFORD SHAPER.

The accompanying half-tones, Figs. 1 and 2, and the line engraving, Fig. 3, illustrates a shaper equipped with a new positive speed changing device, which has been placed on the market by the Rockford Machine Tool Co., Rockford, Ill. In

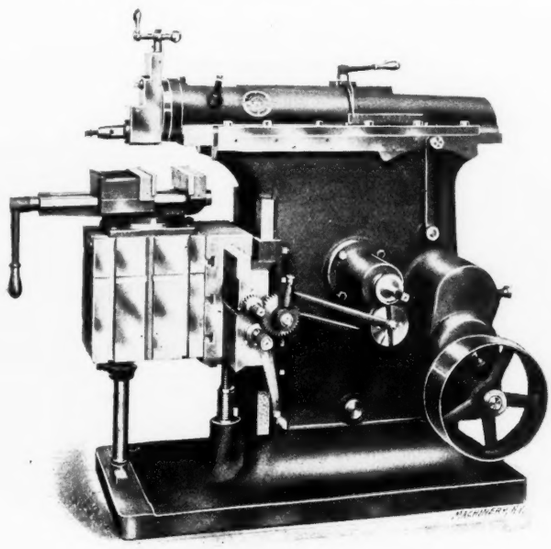


Fig. 1. Belt-driven Geared-drive Rockford Shaper.

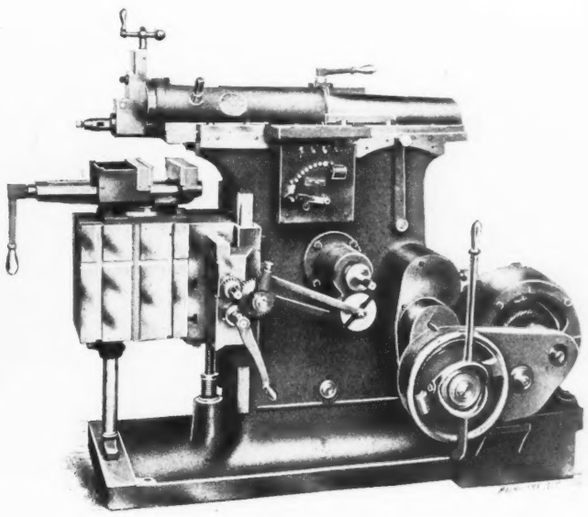


Fig. 2. Motor-driven Geared-drive Rockford Shaper.

Fig. 1 is shown a machine equipped with a single pulley, belt-driven from the counter-shaft. In Fig. 2 is shown a motor-driven machine, direct-connected by gearing to a Northern constant speed motor. This design is provided with a friction clutch for stopping and starting the machine without stopping or starting the motor, a long lever on the side of the machine at the outside end of the gear box operating this friction clutch. In the line engraving, Fig. 3, is shown an arrangement where the machine is belt-driven, but equipped with a friction clutch of the same type as that on the motor-driven machine, so that the driving pulley may be driven by belt directly from the line shaft, no counter-shaft being necessary. The line engraving, Fig. 3, also showing a section through the driving mechanism and an end view of same, gives a comprehensive idea of the design of the gear box and shifting mechanism, the simplicity and carefully thought out design of which is plainly in evidence.

The machine has eight speed changes for the ram, arranged in geometrical progression from 12 to 90 cutting strokes per minute. Referring to Fig. 3, the lower shaft *F* carries the friction pulley and clutch and two driving gears, either one of which may be locked to the shaft by means of a spring key. The gear not locked by the key will run loose on the shaft, driven by its mate on the second shaft *G*. The position of the spring key is changed by operating the lever *H* on the back side of the gear box frame. This lever is connected to a fork *E*, which, in turn, engages sleeve *J* on shaft *F*, by means of which the spring key is moved, so as to engage with either of the two driving gears. A sleeve carrying four gears, any one of which may be engaged with its corresponding gear on the upper shaft *K*, is keyed to the second shaft *G*. The shifting of this sleeve is effected by the shifting lever *D* on the side of the shaper, which connects with the sleeve through the forged levers and links *A*, *B*, and *C*. The lever or arm *A* immediately effects the motion of the sleeve and gears on the shaft *G*. The arm is carried in a bearing at its lower end, as shown in Fig. 3, and is provided with a steel pin at the upper end, which operates between two flanges on the sleeve.

It will be noticed that this arrangement is very simple, and places the two shifting levers within easy reach of the operator. An important feature of the design is that it is impossible to get any two combinations of gears in mesh at the same time. A speed plate is provided, showing the proper location of the two levers for the correct speed required. It will be noted, in particular, that the gear-driving device is very compact, and that the parts are easily accessible. The machine itself is of the regular Rockford design.

Conforming to their usual practice of not placing any new device on the market before it has been thoroughly tested in their own shops, the builders have been constantly using a 16-inch shaper equipped with this gear-driving device for a period of eighteen months, and is operation has been very satisfactory. The floor space required is less than that of a cone-driven machine.

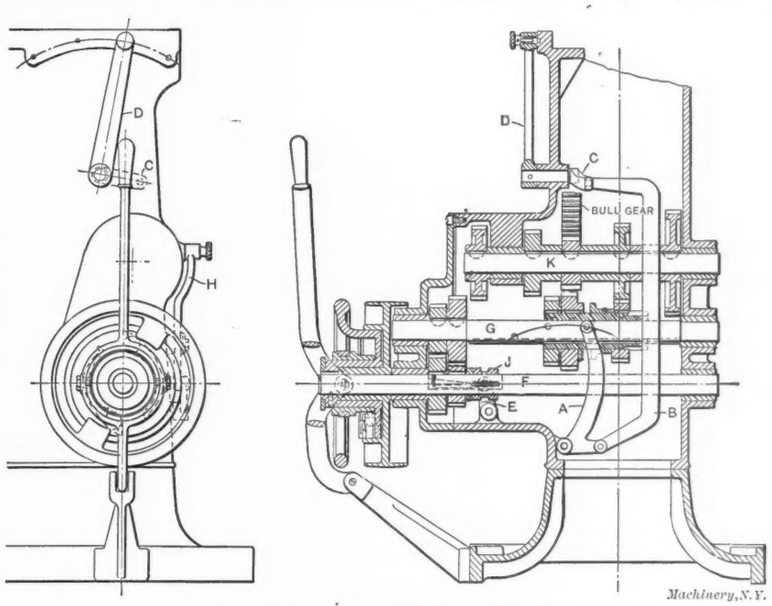
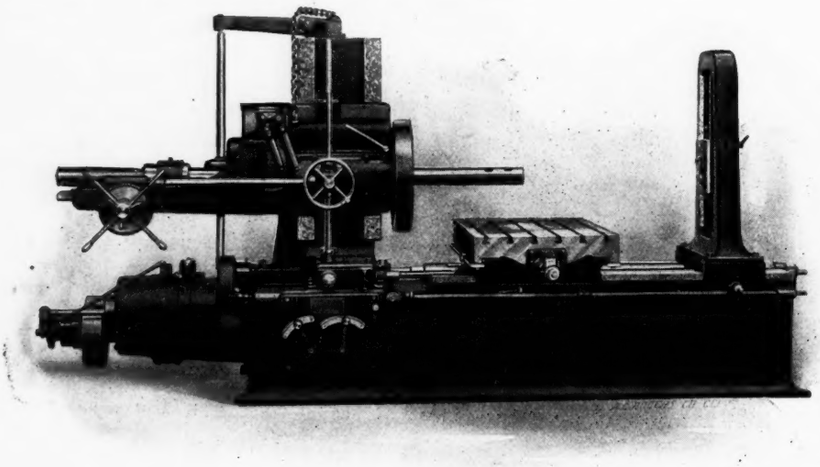


Fig. 3. Section through End View of Gear Box.

LUCAS HORIZONTAL BORING, DRILLING AND MILLING MACHINE.

In the July issue of MACHINERY a description and illustration appeared of a No. 3 precision horizontal boring, drilling and milling machine, built by the Lucas Machine Tool Co., Cleveland, Ohio. The machine shown in the illustration was

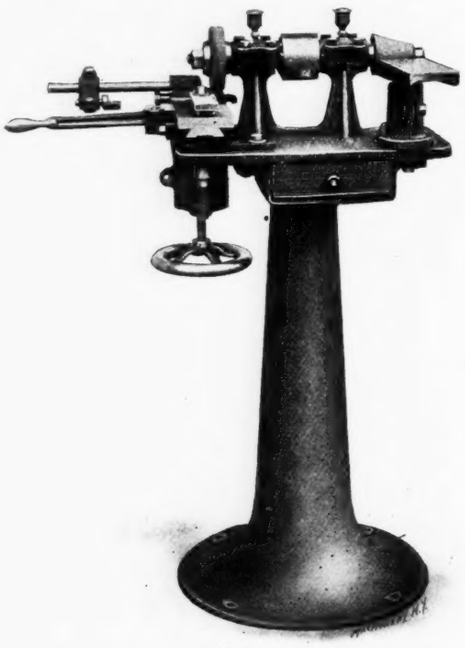


Lucas No. 3 Gear-driven, Precision, Horizontal Boring, Drilling, and Milling Machine.

a cone-driven machine, whereas the description referred particularly to the same type of single pulley gear-driven machine. The latter type of machine which should have been shown instead of the cone-driven one, is reproduced herewith. The description of the mechanism of this machine will be found by referring to the July issue.

BIGNALL & KEELER DIE-CHASER GRINDING MACHINE.

In order that a die may cut a clean and perfect thread, it is of great importance that the die chasers are provided with proper rake and clearance; if not, the threads cut are liable to be torn or stripped. It is equally important that a die chaser be kept sharp, as it is, for instance, that a



Bignall & Keeler Die-chaser Grinding Machine.

lathe tool or a milling cutter be kept properly sharpened. As a rule, however, in most shops but little attention is given to the proper grinding of die chasers, and ordinarily no two chasers in the same die are ground alike. This mainly depends upon the fact that in the average shop there is no machine specially intended for doing this class of work.

Recognizing that there is a demand for a machine which will properly carry out the work mentioned, the Bignall & Keeler Mfg. Co., Edwardsville, Ill., has placed on the market the die-chaser grinding machine illustrated in the accompanying half-tone. It has been the aim of the makers to produce a simple and convenient tool which could be easily and rapidly operated, and which would require no particular skill of the operator of the machine. As seen from the illustration, the machine is provided with a special formed wheel on one end of the spindle. The die-chaser is clamped on the slide beneath the wheel, and is moved back and forth with a lever, the slide at the same time being gradually raised up closer towards the wheel by means of the hand-wheel shown. A gage on the slide, against which the die-chaser is placed, is adjustable at any angle with the wheel, in order to make it possible to grind straight thread die-chasers, as well as chasers for regular taper pipe dies. The shape of the wheel gives the die the correct angle of rake. A templet is furnished with the machine which will assist in dressing the wheel to the correct shape; a wheel dresser is also furnished. The cone-shaped wheel shown at the other end of the spindle is intended for grinding the lead or chamfer of the die-chasers. The specially shaped wheel at the left-hand end can easily be removed, and a straight face wheel used in its place, when it is required to grind tools other than die-chasers. The machine requires a floor space of 20 x 30 inches and weighs 425 pounds.

TRIPLEX BUFFING WHEEL.

A remarkable improvement in buffing and polishing wheels has been made by an invention of Mr. William A. Painter, of Pittsburg, Pa. This buffing wheel, known as the "triplex buff," is shown in the half-tone, Fig. 1, the construction also being indicated in the line engraving, Fig. 2. The buffing wheel is manufactured by the Zucker & Levett & Loeb Co., of 516-524 W. 25th St., New York City. The buffing wheel is made of the same grade of muslin as ordinarily employed for buffing wheels; but shows remarkable wearing qualities, the secret of the improved wearing qualities being in the manner in which the disks of muslin are folded and attached together. Instead of simply placing a number of disks side by side as in the ordinary buffing wheel, the Painter "triplex buff" is made in the following manner: A disk, as shown at *A* in Fig. 2 is folded along the dotted line, so as to appear as at *B*. It is then again folded along the dotted line, appearing as at *C*. A number of these folded sectors, the material of which is then four-ply, are arranged in a wheel as shown at *D*, each sector entering in between the folds in the next previous sector, for about 45 degrees of its full 90-degree angle. The prime object of this manner of making the wheel is to prevent the threads of the material at the edge of the wheel from pulling out, and fraying on the working edge. It is evident that in wheels consisting of plain circular disks, when fraying is started, it will continue all around the wheel, whereas in a wheel built up as described, there is no possibility for a continuous fraying all around the circumference of the wheel, on account of the fact that no one edge of the material continues for more than a quarter turn around the wheel.

There is another very important feature in connection with this method of making buffing wheels. When the wheel is worn down to, say, about half its original size, so that it can no longer be used to advantage, the stubs may be re-made into a wheel of the standard size, using two old wheels to make one new wheel. This is accomplished by fitting the

portions of the old wheel together in a manner as indicated at *E* in Fig. 2. In assembling a wheel of this form, two circular pieces of the diameter of the completed wheel are employed on the outside. One of these is spread out flat, and scrap pieces already folded in quarter sectors are arranged

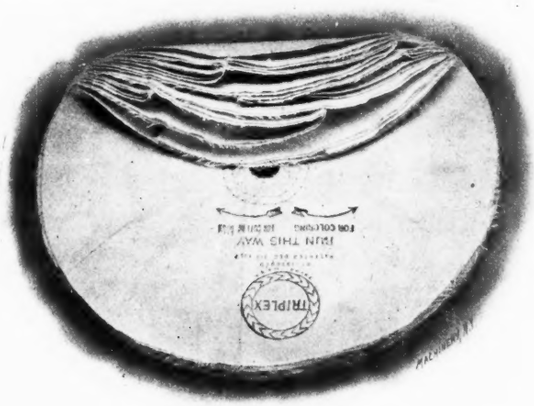


Fig. 1. The Triplex Buffing Wheel.

radially as shown, and interwoven with one another in the same manner as described for the wheel at *D*. When a sufficient number are placed on one another to give the desired thickness, the second outside disk is placed over the folded disks and the folded disks are secured to the two outside ones by staples, the positions for which are indicated at *F*. The re-made buffing wheel is fully equal to the original buffing wheel in its wearing qualities.

The triplex buffing wheel wears at least twice as long as the ordinary wheel, and in some cases it is stated that the wear has been four times that of the regular buffing wheel.

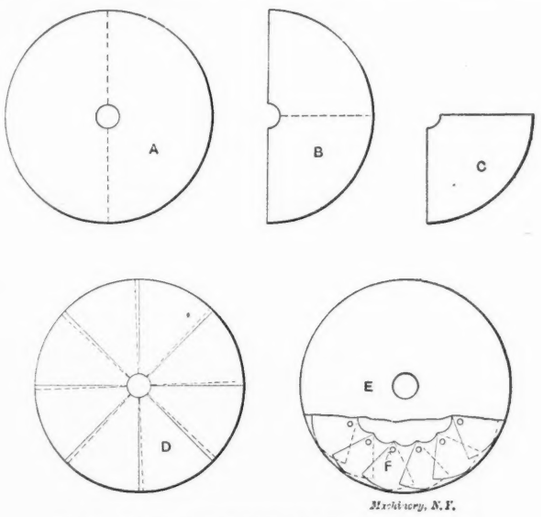


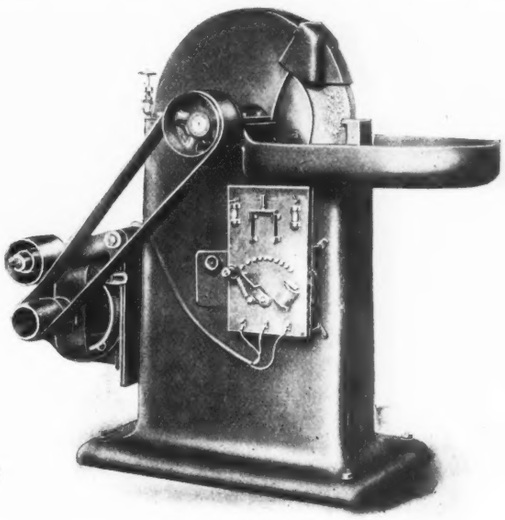
Fig. 2. Illustrations showing the Construction of the Triplex Buffing Wheel.

Another advantage of the wheel is that it saves rouge or other polishing composition to a considerable extent, the construction of the wheel tending to hold the composition in a better manner than does a regular circular disk. Wheels of this description have been in actual use for over a year, and thus do not constitute a mere experiment, but have actually proved their value.

RANSOM MOTOR-DRIVEN TOOL GRINDER.

The illustration herewith shows a motor-driven tool grinder brought out by the Ransom Mfg. Co., Oshkosh, Wis. One of the principal features of this machine is the application of the Ransom patent speed controller, which may be adapted to these machines when used with direct current. This device automatically speeds up the motor as the grinding wheel wears down, thus maintaining the same peripheral speed of the wheel. In general, this device consists of a field rheostat, the arm on which is connected by a link to the so-called water trap, or the piece of the guard at the front of the hood shown in the illustration, which is shoved down as the wheel wears. The connection is made in such a way that the proper amount of resistance is put into the field coils to give the proper speed for the various diameters of the wheel. Attaching the motor, as shown in the illustration, permits any size and type of motor, using any current, to be placed in position.

The water is contained in a large tank holding a month's supply. The tank can be taken out-of-doors for cleaning purposes. The pump is, in reality, a vertical blower in which there are no packed joints, so that the grit in the water does not affect it. A rubber hose is used to feed the water, as it is more easily cleaned than a gas pipe with its elbows and connections. The tool rest is perforated on the inside so that the water shoots through it on the wheel instead of spattering



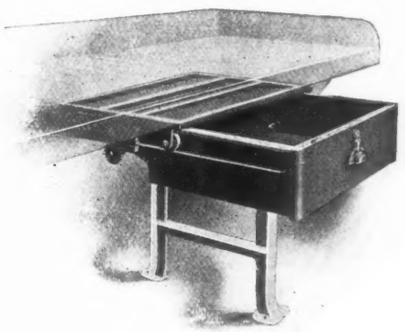
Ransom Motor-driven Tool Grinder.

all over from a nozzle above the tool, as is the case with most tool grinders. On account of this, there is no water on the upper part of the wheel except when running.

On this grinder the wheel is 20 inches in diameter by 1½ inch wide. The floor space required by the base is 20 x 33 inches. The pulley is 6 inches in diameter by 4¼ inches wide, and the weight of the machine is 950 pounds.

NEW BRITAIN BENCH DRAWER.

A bench drawer for machine shop use has been placed on the market by the New Britain Machine Co., of New Britain, Conn. The accompanying illustration shows the appearance of the drawer, the principal features of which are the locking arrangement and the fact that the drawer is sold as a unit, and



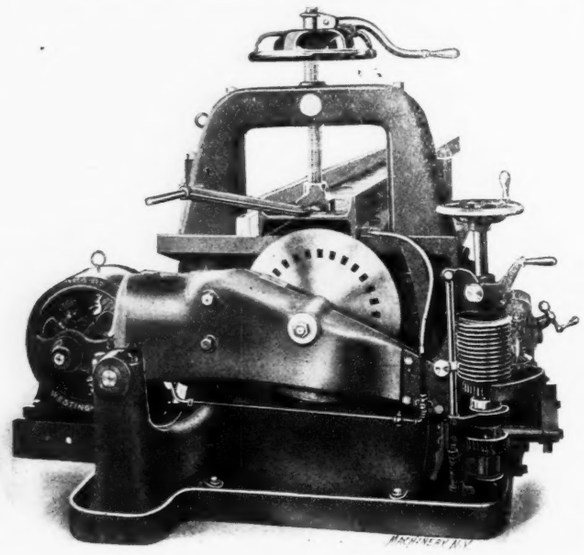
"New Britain" Work Bench Drawer.

can be applied by anybody who can insert a few screws, without any cutting of the work bench. There is no assembling to be done, and there is no damage or loss if it is ever desired to move the drawer. The locking arrangement, as mentioned, is a special feature; when locked, the drawer cannot

be entered or removed without breaking the lock. A smooth plate over the top of the drawer prevents any tampering with it from the rear. The dimensions are such that the drawer is long enough to hold, laid straight, the longest hammer or file a machinist is liable to use, and broad enough to contain the required variety of tools, without piling them on top of one another. Wood is used for the back, top and front, so that fine edge or precision tools may be laid in the drawer without damage. The drawer runs on anti-friction rollers on finished surfaces, giving a smooth movement, and at the same time clamping or wedging of the drawer is entirely prevented by a parallel motion, consisting of a cross shaft and pinions on racks. The inside dimensions are 22½ inches long, 15 inches front to back, and 5 inches deep. The weight, ready for shipment, is 75 pounds.

LEA MOTOR-DRIVEN COLD METAL SAW.

The cold-metal saw illustrated in the accompanying half-tone has been placed on the market by the Lea Equipment Co., 136 Liberty St., New York City, and has been specially designed for motor drive. This adaptation will make it particularly valuable for installation in such parts of the shop where it is difficult to locate a saw driven from a counter-shaft. There are, for instance, in the average machine shop, one or more saws required in the stock room or at some other equally inconvenient place for a belt-driven machine. In such a case, the use of a self-contained motor-driven machine will be particularly appreciated. The machine is fitted with a Westinghouse variable speed motor, having a speed range of from 1 1/3 to 1, with a speed controlling rheostat. It is only necessary to move the handle of the controller to obtain any desired speed. The size of machine shown in the illustration requires a 3½ H. P. motor, and is capable of cutting off round stock up to 8 inches in diameter. The motor is connected with the driving shaft of the saw by a Morse silent chain, direct-connected gearing having been eliminated because experiments have shown that a chain drive is more satisfactory. The variable speed of the motor permits adjustment of the cutting speed for different materials, in order to obtain the maximum efficiency of the saw. The most advantageous peripheral speed of the saw is 52 feet per minute with a very coarse feed for structural iron, machine steel, and similar materials. For annealed steel a lower speed of but 37 feet a minute gives greatest efficiency. The same speed is also used on chrome-nickel steel. The cutting-off machine itself is heavily and rigidly designed and embodies all the features required of an up-to-date tool of this description.



Lea Equipment Co.'s Motor-driven Cold Metal Saw.

CONKLING REVERSING DEVICE.

The accompanying half-tones illustrate the application and construction of a new mechanical reversing device which has been designed by the Conkling Company, Chicago, Ill. The particular features of this device are that it is applicable to any machine requiring reversing, that it will reverse without shock, is self-adjusting, and automatically takes up the wear. The device is running in oil so that the wear, therefore, is reduced to a minimum.

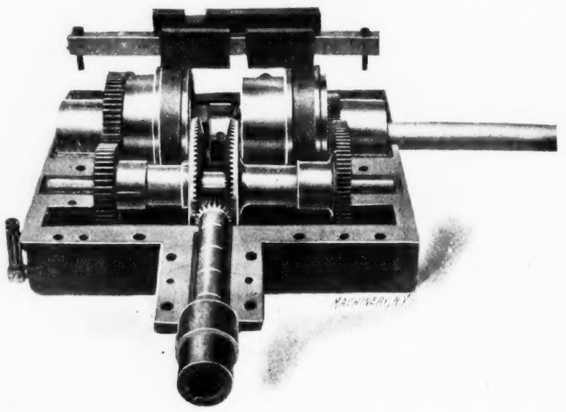


Fig. 1. Construction of Reversing Device—Upper Half of Cover removed.

In Fig. 2 the device is shown applied as a reversing mechanism to a planer. In this capacity the mechanism has been in operation in the Conklin Company's shop on a planer, used in connection with an individual motor drive. When applied as shown, the platen of planers ranging in size from 24 to 40 inches can be run on the return stroke at a speed of 200 feet per minute. Ordinarily the platens of these sizes of planers are not run on the return stroke at a higher speed than 75 feet, or at most 100 feet per minute.

Referring to Fig. 1, this illustration shows the construction of the reversing mechanism. The shaft extending at the right is coupled to the pinion shaft on the planer, while the other shaft extending toward the front of the device is connected to the driving motor. On this shaft is placed a bevel pinion driving one bevel gear on each side, these gears, of course, running in opposite directions. The gear at the right runs the platen on the return stroke at high velocity, and the gear to the left drives the planer on the forward stroke. The manner in which the speed reduction is obtained is easily visible from this illustration, a large spur gear being placed to the right.

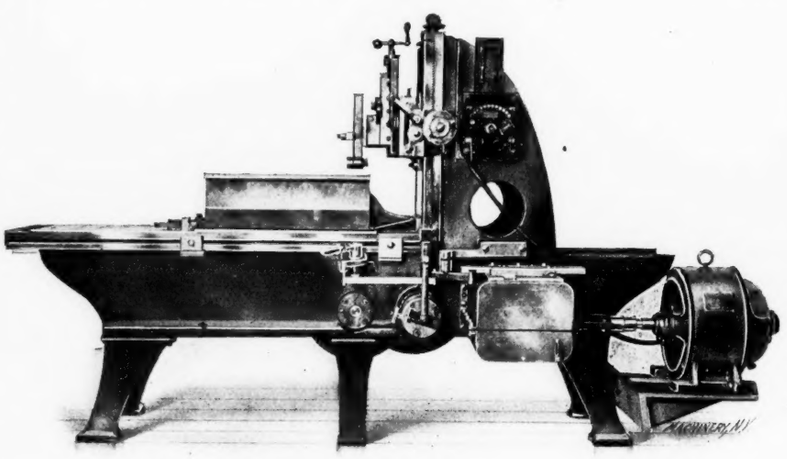


Fig. 2. Planer equipped with Conkling Reversing Device.

meshing with a smaller one on the planer driving shaft, while to the left a small spur gear on the same shaft as the bevel gears drives a large gear on the planer driving shaft. On this latter shaft are placed the clutches by means of which either of the spur gears on this shaft are connected with the shaft itself, the controlling yokes being shown in place in the illustration, together with the bar by means of which they are operated. To the extreme left in Fig. 1 is shown an oil gage glass which shows the depth of oil that should be kept in the gear case.

This device can be applied to any planer, whether new or in use, and in connection with individual motor drive it adds a valuable feature to the machine.

DUST EXHAUSTER FOR WALKER SURFACE GRINDER.

The accompanying half-tone and line engravings illustrate the arrangement and construction of a dust exhauster for surface grinding machines, recently brought out by the Walker Grinder Co., Worcester, Mass. The device consists principally of an ordinary exhaust fan, mounted over an iron receptacle partially filled with water, and exhausting downward into the tank. The hood over the grinding wheel is provided with a large mouthpiece on the rear side near the bottom, so arranged that it is in close proximity to the work and so that the natural course of the sparks from the grinding will be toward the suction pipe. The detailed construction is

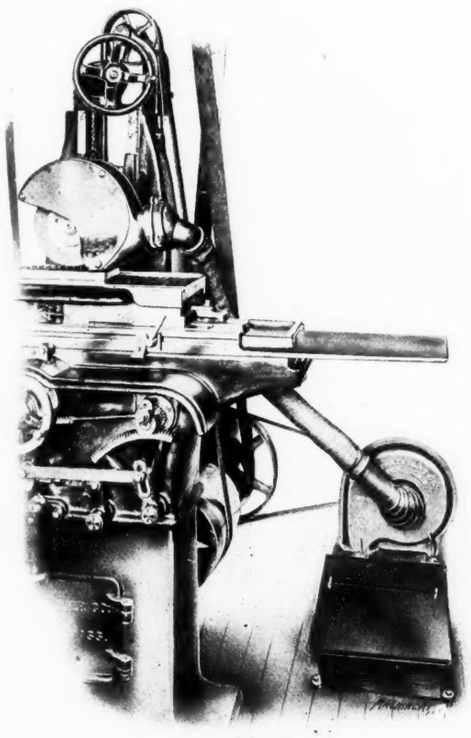


Fig. 1. Arrangement of Walker Exhauster for Surface Grinder.

very plainly shown in Figs. 2 and 3. In Fig. 2, *A* is the grinder hood provided with a detachable side *B*, for the purpose of being able to easily remove and replace the grinding wheel when required. The mouthpiece of the hood is lined with a leather cone *E*, forming a seat for the ball joint exhaust connection *C*, which is held in place by the ring *D*, which is concaved on the inside opening so that it may be set to any desired angle, and clamped by means of screws *F*. The hood *A* is fastened to the grinder head and swivels around the axis of stud *G*, being clamped in position by a screw passing through the oblong slot *H*. This adjustment is introduced for the purpose of setting knife *K* of the device, so that it will just clear the top of the work, and also to provide for different diameters of wheels. The wheel shown in the half-tone Fig. 1 is about half worn out.

The fan, mounted on the water tank, as shown in Fig. 3, is driven from a 14-inch pulley on the drum counter-shaft, belonging to the surface grinder itself. If preferred, the fan can be belted to a counter-shaft in the ceiling, but as there is

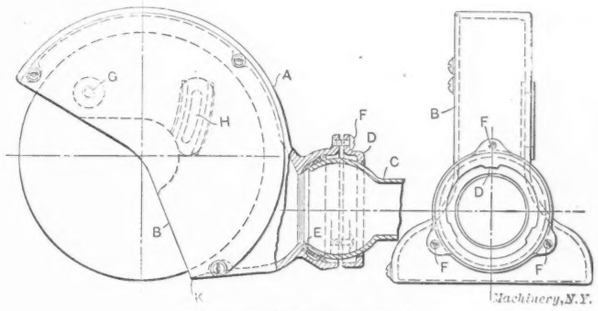


Fig. 2. Dust Exhauster Hood.

no objection to the arrangement shown, it is recommended on account of being very compact, and also because it has the merit of being self-contained. The tank is provided with a cover *M*, which can easily be raised at the front for the purpose of cleaning, and renewal of the water.

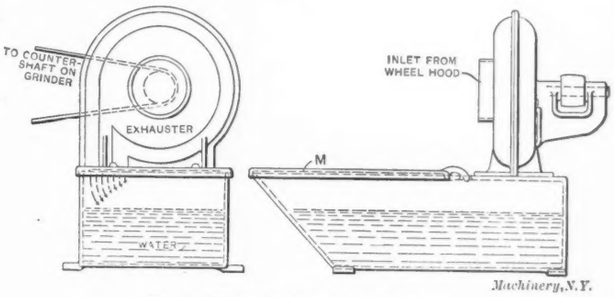
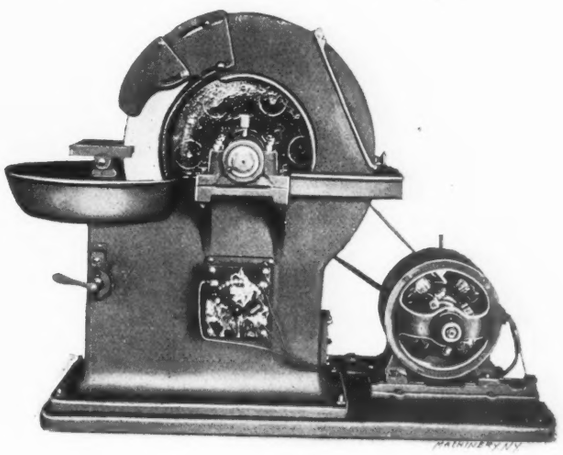


Fig. 3. Water Tank and Fan Exhauster.

The Walker Grinder Co. has had one of these devices in operation in its own shops for several months, and has found it highly desirable for a machine used for dry grinding. While it is not claimed that the device takes care, entirely, of the metal dust from the grinding, it does exhaust all the fine dust, so that the air is not contaminated, and the slight amount of metal dust remaining is of no consequence.

MOTOR-DRIVEN TOOL GRINDER.

The wet tool grinder illustrated herewith, arranged, as shown, for motor drive, has recently been placed on the market by the Safety Emery Wheel Co., of Springfield, Ohio. The main feature of the new machine is the arrangement of the



Safety Emery Wheel Co.'s Motor-driven Wet Tool Grinder.

motor drive, which has been decided upon in order to comply with the requirements for a practical and convenient machine. The advantages obtained by this arrangement may be stated as follows: the motor is easy of access, the space in front and

on the sides of the grinder is unobstructed; there is no difficulty in renewing the wheel; and the belt connection between the motor and the wheel prevents undue wheel shock from being transmitted to the motor, and, at the same time, the belt tension is easily adjusted by moving the motor slightly back and forth on its base-plate pads. Incidentally, the advantage of being able to use any standard motor is gained, the pulleys being proportioned accordingly. The machine and the motor, although independent of each other, as shown in the illustration, are both mounted on the same sub-base plate, so that the motor forms an integral part of the complete machine. The controller is placed very conveniently on the side of the machine, as shown. As regards the grinder itself, it possesses some valuable features not commonly found. Long tools, bars, etc., can be ground by opening a hinged door or cover in the back of the gear guard. The motor is properly covered to prevent any disastrous effects from the water which may spray over it from this grinding operation. Topheaviness is avoided by ample distribution of metal near the base.

SPUR GEAR HOBBING MACHINE.

A machine for hobbing spur gears, remarkable for its simplicity of design, has been brought out by the Moline Tool Co., Moline, Ill., and is illustrated in the half-tones, Figs. 1 and 2, Fig. 1 showing a general view of the machine, and Fig. 2 a view of the machine from above.

The machine is a marked departure from any previous designs of spur gear hobbing machines. A feature that at once demands the attention of the observer is that the hob spindle is set at a permanent angle to the travel of the gear blank and is not adjustable, which, as far as we know, is a feature wherein the tool differs from all other machines for hobbing gears. Thus the spiral angles of all the hobs are set the same, and the hobs are made of different diameters in order to allow for the different pitches. For the finer

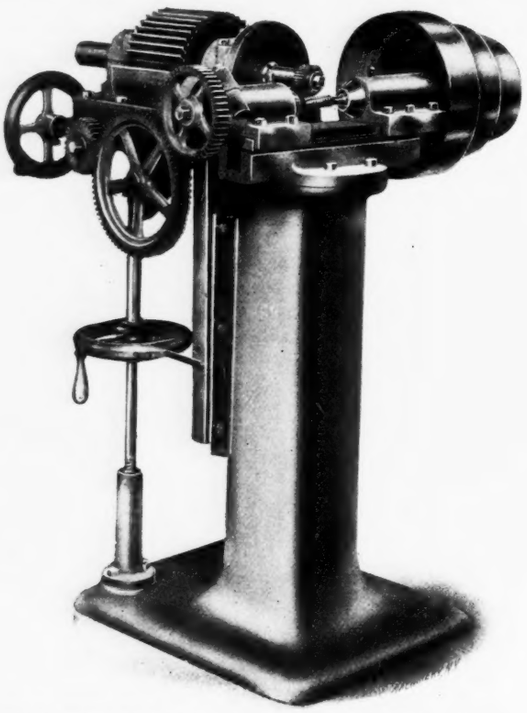


Fig. 1. Moline Tool Co.'s Automatic Spur Gear Hobbing Machine.

pitches, where the hob would become too small to be advantageously used, it is made with double thread. As is very plainly shown in Fig. 1, the hob spindle on which the driving pulley is mounted is connected by gearing to a shaft *A*, Fig. 2, at the rear of the machine, from which the rotary motion to the gear blank is transmitted. This motion, however, is not transmitted to a worm-wheel from the worm on shaft *A*, but instead of a worm-wheel a master spur wheel is used, which has sufficient width of face to traverse past the worm on the shaft *A*, Fig. 2, when the blank is fed forward. The worm shaft runs in an adjustable bearing, so that the worm can always be kept in proper mesh with the master wheel. The worm is cut at the same angle as are the hobs, so that the worm shaft and hob spindle are set parallel with each other, and are permanently in line. It is evident that this greatly adds to the simplicity of the design.

The master wheel *B*, Fig. 2, is mounted directly on the work-carrying spindle, and is mounted in bearings on a car-

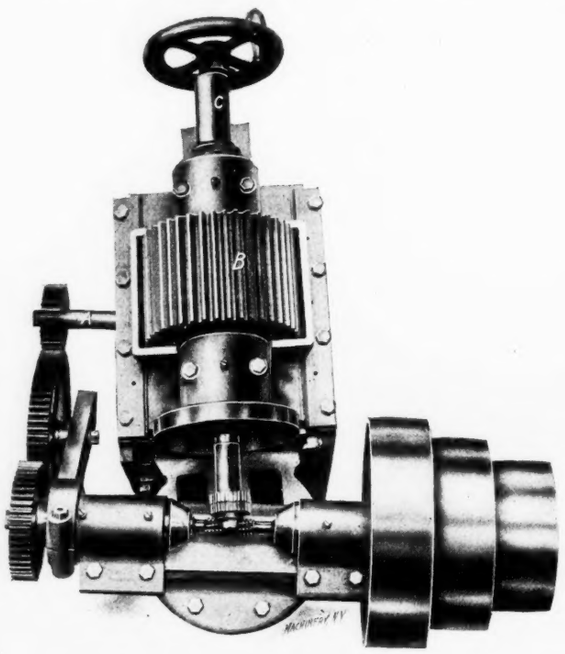


Fig. 2. Top View of the Spur Gear Hobbing Machine.

riage or slide, which is fed automatically forth and back, so that when the master wheel traverses past the master worm, the blank to be cut is traversed past the cutting hob. On account of the parallelism between the hob and the worm-driving master gear *B*, the matter of gearing is very much simplified, and, in fact, is no more complicated than that of the gearing in an ordinary screw-cutting lathe.

The feed of the carriage is directly from gears mounted on the rear end of the work spindle at *C*, Fig. 2, to gears on the feed-screw directly below. The end of the feed-screw is provided with a hand-wheel for feeding by hand. In the half-tones, the feed gear on the end of the work-carrying spindle and the feed-screw gear, are removed and are not visible. There is also a cover over the master gear *B*, which is removed in order to show this part.

The hob end of the column, under the hob and work, is open, so that all the chips fall directly into the opening, and are removed through a door at the bottom of the column on the back side of the machine, thereby avoiding scattering the chips around the floor. This machine is made in one size only, and has a capacity of cutting spur gears up to 12 inches in diameter, 5 diametral pitch, and 6-inch face.

GARDNER COMBINATION DISK GRINDER.

In the July, 1908, issue of MACHINERY a double disk grinder, built by the Gardner Machine Co., Beloit, Wis., was described and illustrated. The company has also brought out a combination disk grinder, consisting of the grinder as previously shown in MACHINERY, and fitted with a third wheel on the right-hand end, and with a rocker shaft fastened in the base of the machine on which any style of work table may be mounted. A style of table particularly convenient for manufacturing purposes, where rapid handling of duplicate pieces is required, termed the universal lever feed table, is particularly recommended. This table has a vertical and angular adjustment and is counter-balanced. The top surface of the table is provided with T-slots for bolting fixtures or holders

for the work. The table is operated by a hand lever, and is adjusted by a micrometer stop screw, graduated to 0.001 inch. When the right-hand end of the machine is used alone, the head carrying the double disks is uncoupled from the rest of the machine. When the machine is not used for double-face grinding at all, the movable head can be entirely removed, and a special table substituted for single-face grinding. The weight of this machine, which is termed No. 12 Combination Gardner's improved disk grinder, with all its accessories, crated for domestic shipment, is 2,200 pounds.

NORTON MOTOR-DRIVEN GRINDING MACHINE.

The accompanying two half-tones show a front and back view of a new grinding machine which has been brought out by the Norton Grinding Co., Worcester, Mass. This machine is known as a 20 and 32x168-inch self-contained electric drive grinding machine, the name being derived from the fact that the machine swings 20 inches, except in the gap plainly indicated in Fig. 1, where it will swing 32 inches. One of the principal features of the machine is this gap arrangement. In the grinder shown in the half-tones the gap is in the center of the table and is 44 inches long. The gap can, however, be made of any length and placed at any position on the table to suit the work for which the machine is especially intended.

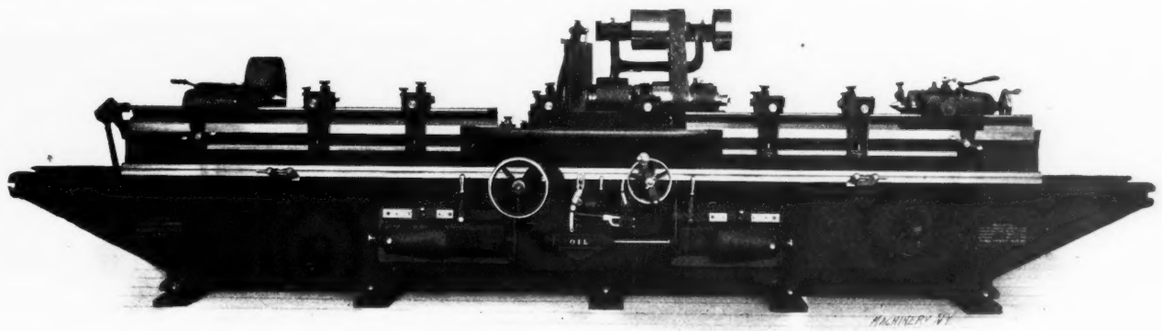


Fig. 1. Front View of Norton Self-contained Motor-driven Grinding Machine.

The rear view of the machine, Fig. 2, shows the manner of application of the electric motor. It will be seen that no extra floor space is required for the motor, as it stands within the rectangular outlines defined by the extremities of the base of the grinding machine itself. The motor should be of 20 horse-power for large and heavy work, but if the machine is regularly used for small work, a smaller motor could be applied, the makers stating that from 5 to 20 horse-power should be reckoned upon, according to the character of the work and the ambition of the operator in turning out the product. The details of the construction are practically the same as those of the regular sizes of the Norton grinding machines, and the same methods of construction as employed in the building of the regular types have been adhered to. The foot-stock is arranged for sensitive adjustment in order to secure straight work, and both the head and foot-stock are made extra heavy to insure durability as well as accuracy when heavy work is supported. The grinding wheel used with this machine is 24 inches in diameter by 4 inches face.

The plates shown under the grinder bed in both Figs. 1 and 2 are intended to be carefully imbedded to straight-edge and level in the foundation of the machine. Wedges are used under the machine, resting on these plates; these wedges are adjusted with two nuts, one on either side of the projecting end of the wedge, the nuts being operated on threaded studs fixed in the base of the machine. Both the plates and the wedges are machined to insure broad permanent contact.

The machine shown in the half-tones was made especially for a German railway works, for grinding crank-pins, valve stems, truck axles and piston rods, the pistons having extension rods. Steady rests are shown mounted on a base, which is arranged to be moved along the front edge of the gap, to accommodate different thicknesses and different positions of pistons. These rests with their base can be removed to give a clear space over the entire gap. The total length of the machine is 22 feet and the total weight is 25,000 pounds.

PORTABLE ELECTRIC RADIAL DRILL.

The accompanying half-tone illustrates a portable electric radial drill placed on the market by the United States Electrical Tool Co., Cincinnati, O. The general features of this machine are plainly indicated in the illustration. The drill is fitted with a rack and pinion for feeding the radial arm outward, and it can drill at a radius of 32 inches at any place in the horizontal plane and at any angle. The radial arm is provided with an index line and a corresponding line is made in its sleeve, so that the drill can be set in a perfectly vertical position in a very few seconds.

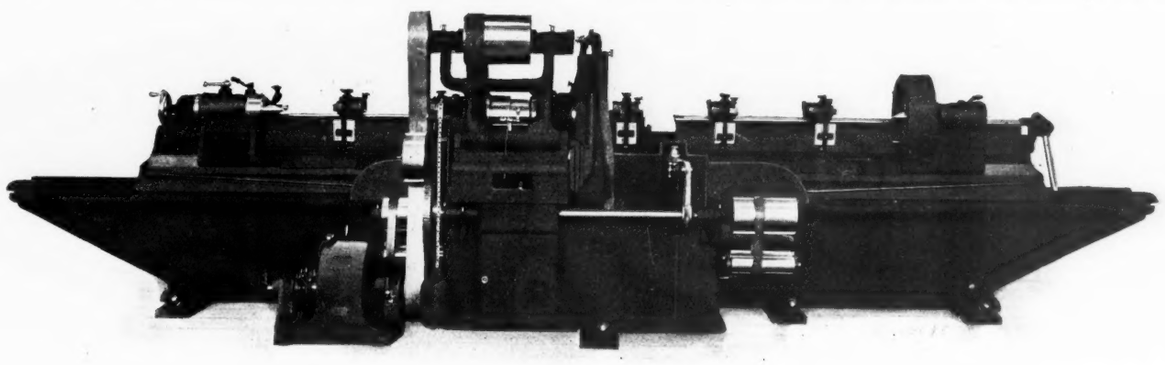
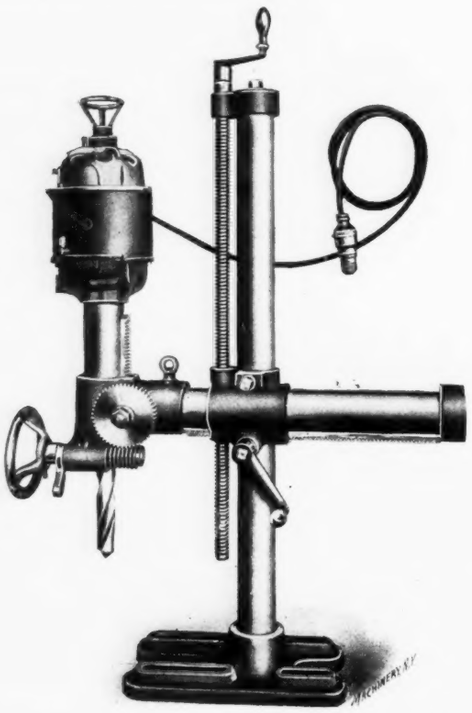


Fig. 2. Rear View of Grinding Machine, showing Arrangement of Motor and Drive.

The drill can be fed downward 5 inches by means of the hand-wheel shown to the left in the illustration, which, through a worm and worm-wheel, connects with the usual rack and pinion feed arrangement. On the back side of the machine, not shown in the illustration, a crank is provided for quick return by hand. The vertical column and the horizontal arm are made of a hollow steel tubing, the column being fitted with a screw to raise and lower the arm. The drill spindle is fitted with thrust ball bearings. The motor is of the air-cooled type, and the current is taken directly from an ordinary incandes-

cent lamp socket, the motor being supplied either for direct or alternating current. The hand-wheel shown on the top of the electric drill motor, is used for knocking out the twist drills.

It will be noticed that the horizontal arm is fitted with an eye-bolt so placed that the device counterbalances at this point. This eye-bolt is used for carrying the drill about the shop



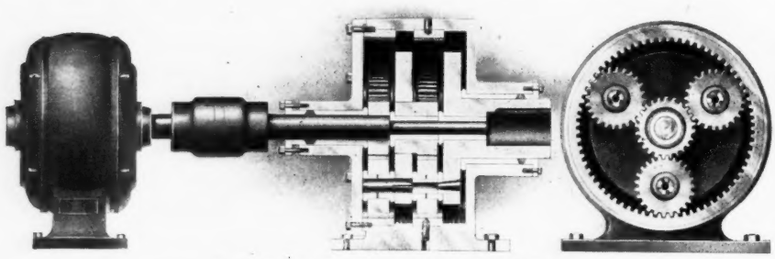
United States Electrical Tool Co.'s Portable Electric Radial Drill.

with a crane or hoist, or by placing a bar through the eye-bolt for two men to carry the drill, the weight of which is 160 pounds.

These drills are made in two sizes, one intended for drilling holes up to ⅞-inch in steel, and the other for drilling 1¼-inch holes in the same material, the drill spindle being fitted with a No. 2 Morse taper socket for the smaller size, and with a No. 3 socket for the larger size drill.

SPEED REDUCING GEAR.

The accompanying illustration shows a speed reducing gear intended particularly for reducing the speed from the motor driving shaft to any required speed of the driven shaft on the machine to which the motor is connected. As plainly shown in the illustration, the design is based on the principle of using planetary gears, two sets of which are used in order to bring down the speed reduction to the required ratio. The mechanism is entirely encased and oil-tight. The special advantage of this reducing gear is that the power is taken from



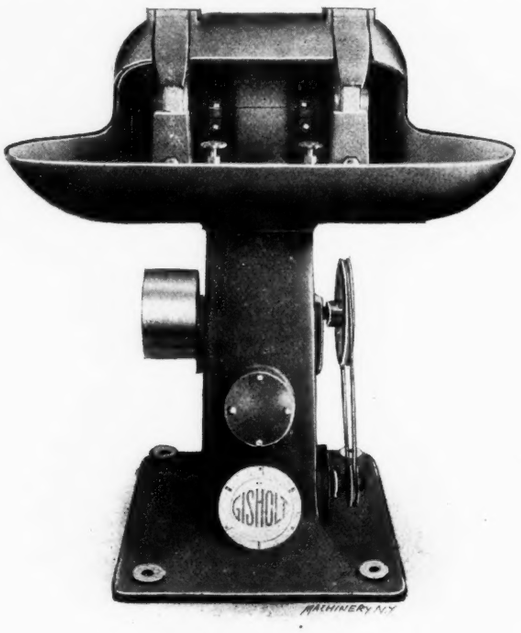
D. O. James Mfg Co.s Speed Reducing Gear.

three points, and all the moving parts run in the same direction, so that it gives a balanced drive that has a greater margin of safety than a drive with one or two planetary gears would have, and it requires practically no attention. The annular or internal gears are made of semi-steel, the idlers being made of steel, and bushed with hardened steel bushings. The bearings are bushed with phosphor-bronze. The device is made in a variety of sizes and speed reductions, for ⅛ to 50 H.P., and can be arranged either vertically or horizontally. A universal coupling is also made by the makers for connecting the motor to the reduction gear shaft, which obviates the necessity for perfect alignment between the motor and the device.

Several applications of the use of this speed-reducing gear could be mentioned. In one case, for instance, a 5 H.P. vertical motor driving a vertical shaft is provided with a speed-reducing gear having a reduction ratio of 73 to 1. In another case a 7½ H.P. motor with a reduction gearing of 4 to 1, is direct connected to a worm-gear elevator, this drive eliminating the objectionable belt drive. In another case, a 2 H.P. reduction gear is placed between the motor and an automatic gear-cutting machine, reducing the speed from 1,800 to 245 R.P.M. As a last example we may mention a 5 H.P. motor with reduction gear, direct connected to a line shaft, reducing the speed from 1,000 to 150 R.P.M. This device is manufactured by the D. O. James Mfg. Co., 351-353 W. Monroe St., Chicago, Ill.

GISHOLT DOUBLE EMERY GRINDER.

The double emery grinder illustrated herewith, represents one of the latest machines brought out by the Gisholt Machine



Gisholt Double Emery Grinder.

Co., Madison, Wis. This machine is supplied with two emery wheels, 1½-inch face and 14 inches diameter, mounted on a spindle running in adjustable self-oiling boxes. Any end play in the spindle may be easily taken up by adjusting two screws in the face of the spindle driving pulley. The machine is supplied either belt-driven or provided with motor drive. Several improvements have been embodied in the design of this grinder. The wheels and driving parts are enclosed as much as is possible by suitable guards. The method of water supply largely eliminates the splashing of the water, and materially assists in keeping the floor by the machine dry. A fan water pump and a large water reservoir are provided in order to insure an abundant supply of water. The water nozzle, instead of being at the usual position on the upper side of the work rest, is placed in the back or wheel side of the work rest; the water, therefore, instead of coming from the nozzle directly over the wheel and rest, follows the wheel nearly a

full revolution, and comes around in a fine spray, meeting the work at the point of contact with the emery wheel. The work is thus always in plain view. The machine has a large water pan of such dimensions that a piece of work up to 14 inches in length will come entirely within the pan when grinding, and therefore any drip from it will go directly into the pan, from which it drains into the tank, instead of splashing on the floor. It will be noticed from the engraving that the spindle pulley is well protected, so that the belt is kept entirely free from water and emery, thus materially increasing the life of the belt. The machine is very heavy for its size, and was originally designed by the Gisholt Machine Co. for its own use.

CHALLENGE HIGH-SPEED POWER HACK-SAW.

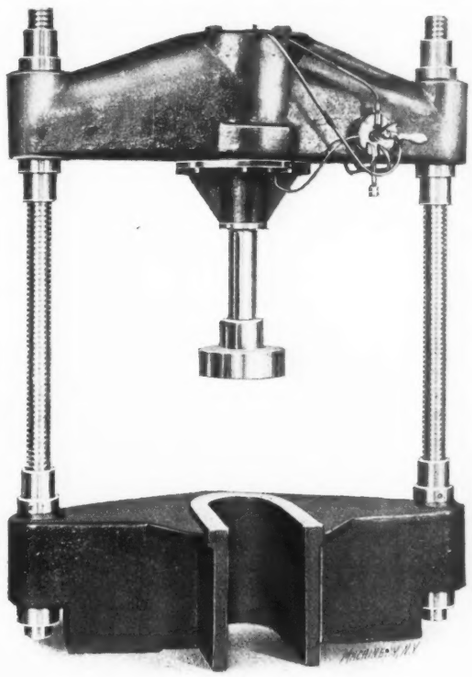
The power hack-saw illustrated in the accompanying half-tone engraving is manufactured by the firm of C. J. Weinman & Co., Dayton, Ohio. It embodies several interesting features, and differs in some respects to a great extent from the ordinary type of power hack-saw. One of the special features of the machine is that a friction device is provided for raising the saw blade from the work on the return stroke, the same device forcing the blade into the metal during the cutting stroke. This on the one hand saves the saw teeth, and on the other, makes the saw cut faster. Another feature of interest is embodied in the design of the connecting arm; by having this slotted in the center, a quick return stroke is accomplished, while the forward stroke is slow. This arrangement adds about thirty per cent to the speed of the machine as compared with a machine of the old type, where the forward and return strokes are at the same velocity. Having done away with the regular type of connecting-rod, the builders have been able to present a machine that is much more compact than the ordinary power hack-saw, making it more rigid and at the same time taking up less space. The machine is provided with a swivel vise for cutting off stock at an angle, and with an adjustable stop for the length of the

C. J. Weinman & Co.'s High-speed Power Hack-saw.

stock to be cut off. The machine has adjustments to insure straightness of cut, and proper adjustment for wear. The most important dimensions are as follows: The capacity of the machine is 4½ x 5-inch stock. The floor space occupied is 15 x 31 inches. The diameter of the driving pulley is 15 inches, the width 2½ inches, and its speed 60 revolutions per minute. The length of saws used is 12 inches. The weight of the machine is 160 pounds.

SPRINGFIELD PNEUMATIC PRESS.

The accompanying illustration shows a pneumatic press designed and built by the Springfield Machine Tool Co., 631 Southern Ave., Springfield, O., for use in the company's own factory for making press fits, as an arbor press, etc. The tool, however, has proved to be so useful that it has been decided to place the device on the market. Besides its vari-



Pneumatic Press built by the Springfield Machine Tool Co.

ous uses in ordinary machine shops, this tool ought to find application in railroad shops, where a large number of bronze boxes are forced into locomotive parallel rods and for forcing crown brasses into locomotive driving boxes, and for many other purposes. The special feature of the press is that it is operated by compressed air. The device consists of two main frame castings and two heavy upright screws. The base casting is of massive proportions, in order to give adequate strength, and is wide enough to permit work 40 inches in diameter to be laid upon it. The opening in the base casting at its center, clearly shown in the illustration, extends back beyond the center of the device, and is for the purpose of permitting a portion of the work, such as a shaft, axle or arbor, to extend below the device a considerable distance.

The upper frame casting contains in its center the air cylinder, 12 inches in diameter, the piston having an 8-inch stroke. If required for special cases, the stroke can be made longer. The piston is fitted with three rings, which prevents air leakage. The lower end of the piston rod carries a heavy circular shoe, as shown in the engraving, the central portion of which is filled with babbitt, so that the work will not be bruised when the pressure is applied. The object of threading the two uprights is to permit adjusting the upper casting to whatever height is required by the work. By the use of the adjusting screws the press can be made to accommodate almost all classes of work.

The operation of the air for the piston is through a valve at the right-hand side of the upper frame casting, this valve controlling the air both above and below the piston. The valve is very simple in its operation. As it is moved from the left-hand position the piston is raised, while a further movement will shut off all the air; then by moving the handle still further in the same direction, the piston is lowered, which permits the full air pressure to be applied to the work. If the pressure thus obtained does not prove to be sufficient to give the desired results, a further movement of the controlling handle in the same direction throws into operation a small, quick-acting air pump, which is placed on

the top of the upper frame, but not shown in the accompanying engraving. This pump is capable of raising the pressure to 250 pounds, when the main line is supplied with air having 80 pounds pressure to the square inch. The air supplied through the valve is so regulated that the piston cannot move too rapidly in either direction. The press as shown, without the auxiliary pump, when supplied with air of 80 pounds pressure per square inch, is capable of exerting a total pressure of 8,800 pounds at the end of the piston rod, but when the pump is brought into action, it will exert a total pressure of 27,000 pounds.

TOLEDO DOUBLE-PITMAN GANG PRESS.

The demand for machines for performing punching operations rapidly and economically, as well as the activity of the manufacturers of this class of machines, is exemplified by the fact that hardly a month passes without our recording some progress in press design. In the half-tone, Fig. 1, and the line engraving, Fig. 2, a general view and the design of a double-pitman gang press, brought out by the Toledo Machine & Tool Co., Toledo, Ohio, is shown. This press is designed for operating a gang of six sets of dies for cutting out the tops or bottoms of tin cans, but the press can, of course, be used for various other classes of work of a similar nature. It is set in an inclined position in order to permit the sheet metal to feed through by gravity. The press has a capacity for producing 200,000 pieces of this character in ten hours, and its construction embodies several interesting features, which we shall refer to in detail.

When first placing the sheet in the press, the hand lever just visible on the left-hand side of the press in Fig. 1 is operated, after which the press is started in the regular manner by the foot treadle and runs continuously for the required number of

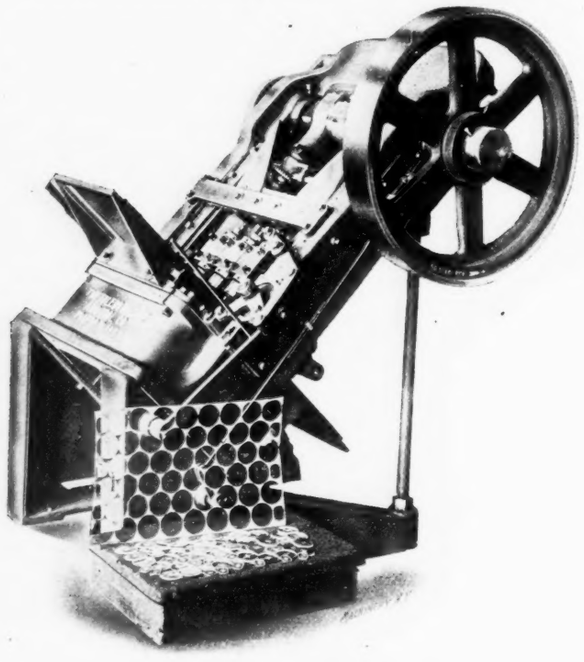


Fig. 1. Toledo Double Pitman Gang Press.

strokes to finish the sheet. At this point the press is automatically stopped by a cam movement of the disk at the right-hand side of the housing, which disengages the locking device for the foot treadle, and in this manner releases the driving clutch. The hand lever shown in Fig. 1 on the right-hand side of the press, enables the operator to instantly release the clutch mechanism, before the completion of the entire sheet, at any stroke required.

The relative position of the dies is shown in the line engraving, Fig. 2, which also shows in the sectional view the construction of the dies, and the independent means for control and adjustment of each die. The six dies are set in two rows in an alternate or staggered position in order to be able to use up the amount of stock to its fullest extent. How well this latter object is obtained is shown by the scrap left from the punching operation, which is shown in front of the base of the machine in Fig. 1. This illustration also shows how in a separate punching operation in another press the small amount of scrap left in three places at each end of the sheet is used up for rectangular can bottoms. This procedure, and the arrangement of the dies reduces the scrap to the smallest amount possible, yet leaving a web of the sheet between the holes to prevent clogging up or buckling of the sheet in the dies. This web, however, is a trifle less than 1/16 inch at its smallest width.

Referring to Fig. 1, it will be seen that the slide proper or main ram is very long, having bearings practically twice the

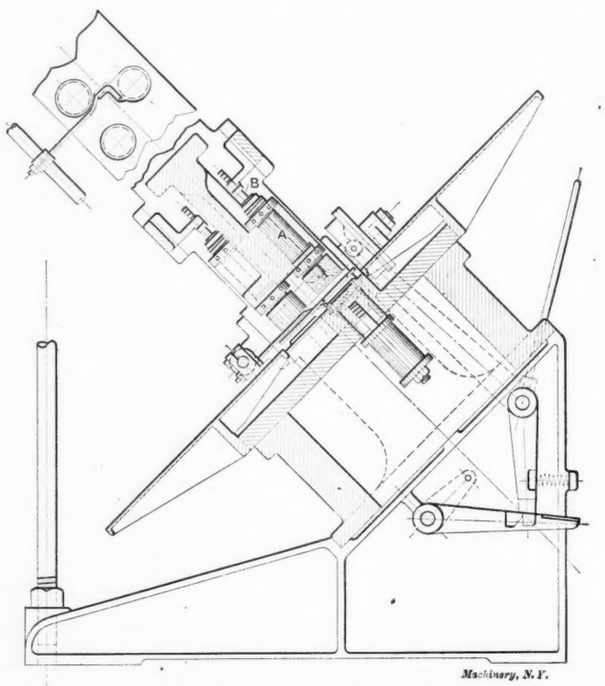


Fig. 2. Section through Press, showing Construction.

length of similar bearings in ordinary presses. Each of the upper dies fits in a recess or socket, the dies being securely clamped in position by means of a cap and four studs, as indicated. These punch holders or upper dies are provided with an adjustment obtained by a threaded shank *A*, Fig. 2, on which collars are fitted above and below the socket or cap, providing in this manner an easily accessible adjustment, in addition to the regular twin gear adjustment provided for the slide or ram proper. The cutting punches or upper dies are screwed to the ends of the shanks referred to, and can be removed for repairs or renewal without difficulty. The lower dies are each mounted separately in independent holders, which are in turn set in recesses in the main bolster or bed plate. In this manner positive and correct alignment of the upper and lower dies is obtained at all times.

An automatic positive knock-out to the upper dies is provided by means of a stem or bar *B*, running down through the threaded plunger or sleeve *A*, shown in Fig. 2, and connecting to the inner pad of the upper die. Directly above this rod or bar, and attached to the cross bar, running from right to left of the press, both in the front and rear of the machine, is the knock-out arm. This arm is fitted with a screw and jam nut, providing an independent adjustment for the knock-out to each set of dies.

The heavy bolster or bed plate is held in position by means of four large bolts. This plate has massive lugs or ears on the right- and left-hand side in front of each housing of the press, and the plate is securely held obviating the tendency to slide downward because of the inclined position.

It is not required to square the sheets to prepare them for this press, and one operation taking considerable time is thereby avoided. As already intimated, each die or set of dies in the group of six may be removed, replaced and adjusted independently of each other in the same manner as when

using similar dies in a single die press. This is one of the principal features of the machine, whereby it overcomes one of the greatest sources of inconvenience heretofore experienced in the use of gang presses.

AMERICAN STEAM GAGE AND VALVE MFG. CO., Boston, Mass. Vest pocket speed counter, registering accurately the number of revolutions in plain figures. The device is very small and convenient to carry.

BIRDSBORO STEEL FOUNDRY AND MACHINE CO., Birdsboro, Pa. Motor-driven cold saw, especially designed for small work. The table on which the work is clamped has vertical and horizontal adjustment, and the saw-carrying head can be swiveled around to any angle desired. Speed variation is effected by using a variable speed motor.

H. C. H. WALSH CO., 2448 W. Kinzie St., Chicago, Ill. Turret bench press carrying four sizes of punches or other tools for punching, bending, shearing, wire cutting, riveting, embossing, etc. The capacity of the machine for punching is a 5/16-inch hole through ¼-inch stock. It will punch holes 1¼ inch from the edge of the stock. The device is built to be worked by hand, but may also be fitted so that it can be worked by power.

HAMILTON MACHINE TOOL CO., Hamilton, Ohio. Double back geared lathe, intended for unusually heavy work or for high speed. The machine is known as style A lathe, and this type is made in all regular sizes up to and including 28 inches swing. Larger lathes are furnished with double gears for doing extra heavy work. The double back-gears can be instantly connected or disconnected by a spring-locking device, and either set of back-gears can be thrown in and out very rapidly.

WILLIAMS TOOL CO., Erie, Pa. Improvement in the company's No. 2 pipe threading and cutting-off machine, principally in the method of the drive. The speed changes are obtained mechanically from a single speed driving shaft which may be either belt or motor driven, the size of motor required being 2 H.P. The drive for the spindle is through gears under the head-stock in the bed of the machine, the changes in gear combinations being made by sliding gears. Six speed changes in all are obtainable.

FAY MACHINE TOOL CO., Second and Glenwood Aves., Philadelphia, Pa. Cam-cutting machine designed especially for cutting cams for textile machinery. The cams usually cut are grooved face cams up to 20 inches in diameter. Cams of other descriptions can, of course, also be cut. The machine has a duplex head, the former or master cam being bolted to one face-plate, while the cam to be cut is held to the other and operated upon by the milling cutter, which latter is driven by a belt independent of the drive for the two face-plates of the machine.

PRATT & WHITNEY CO., Hartford, Conn. Double spindle spline milling machine intended for slotting work of any description clear through, or grooving work to any depth required. It is particularly adapted for milling the oblong openings in drill sockets, tool-posts, boring-bars, etc. The machine is provided with two cam-controlled spindles mounted one on each end of the machine, the table for feeding the work being between the cutters in the center. Each head may be operated independently when a single keyway or a shallow groove is to be cut

---

INGERSOLL MILLING MACHINE CO., Rockford, Ill. Special horizontal spindle milling machine of the planer type provided with a head carrying a vertical spindle and a spindle in an angular direction adapted especially for milling gas engine beds. The machine is of large dimensions, with a distance of 42 inches between the housings, the table being 10 feet long and the weight of the machine 30,000 pounds. While especially intended for gas engine beds, the design of the machine adapts it to any other milling which could conveniently be done on a machine of this size.

EBERHARDT BROTHERS MACHINE CO., 66 Union St., Newark, N. J. Automatic worm-wheel hobbing machine designed for automatically hobbing large quantities of worm-wheels for manufacturing purposes. A cam feed is used, having been decided upon on account of the large quantities of each size gear to be cut, the cam being driven through change gears from the work spindle. The wheels are hobbed without being previously gashed. The machine feeds the head downward to the proper depth of cut, automatically, and proceeds with the hobbing process until finished. When the head returns to its original position, the machine stops.

* * *

MACHINERY SWINDLER ON PACIFIC COAST.

J. J. McCabe, 30 Church St., New York, manufacturer of the McCabe double-spindle lathe, has been informed that a man representing himself as Eddie Ward, and professing to be McCabe's western traveling agent, is at present making a tour of the Pacific Coast, ostensibly selling McCabe's double-spindle lathe. He introduces himself with cards printed in large letters "McCabe" and underneath in small letters "as sure as the hand of fate—New York office, 916 Brent St.; Chicago office, 8 So. Canal St." A few weeks ago Ward called on Mr. James Roake, Oregon City, Ore., and inquired if he was in the market for a double-spindle lathe. Mr. Roake was more interested in a shaper, and gave Ward an order for one which Ward claimed McCabe had taken in connection with other tools from a defunct shop at Suisan, Cal. The shaper was represented as an 18-inch machine in first-class condition, having been used but eighteen months, and fully equipped. It was claimed that the cost of the tool was $425.00 less 6 per cent. Ward "sold" the tool to Mr. Roake for $252.50 and Mr. Roake gave Ward a check for $39.60 to prepay the freight to Oregon City. Neither Ward nor the shaper has been heard from since.

Mr. McCabe informs us that he has no Mr. Eddie Ward in his employ and that the individual representing himself as his representative is an imposter. His Pacific Coast interests are cared for by Harron, Rickard & McCone, of San Francisco and Los Angeles, and by the Hahlidie Machinery Co., of Seattle and Spokane.

* * *

About three years ago B. J. Lambert, professor of structural engineering, State University of Iowa, designed a rather novel blue-print frame, a description of which was printed in the 1908 issue of the *Transit* as follows: The frame proper is of wood with a slightly curved top, over which is stretched a thin sheet of celluloid, fastened firmly at one end of the frame. By means of a cam action and adjusting screws at the other end, the celluloid sheet can be quickly tightened, or released and rolled back to insert tracings, films, and paper. The paper can be examined readily, without removal, by partly unrolling the celluloid cover. In this way the printing can be timed as desired. Rolled tracings, films, and papers are much more readily handled than in an ordinary glass frame. The frame is also very light in weight, gives perfect contact over all the surface, prints as readily as with glass, and is, in all respects, perfectly satisfactory.

* * *

The firm of Hans Renold, Ltd., Manchester, chain manufacturer, has issued an interesting pamphlet, giving accounts of a number of tests made at the works of the firm to ascertain the relative efficiencies of belts and chains for power transmission. The results show a decided advantage in favor of the chain when used for machine tools, both in respect to output and in regard to the finish of the work, the cutting action in machines with chain drive producing a smooth finish, as compared with the results obtained by belt drive. The difference in action is attributed to two causes, the irregular slipping of the belt on the smooth surface of the cone, and a vibrating movement arising out of this slipping, owing to the elongation and the contraction of the belt under the tension of the power transmitted. The tests have been extremely thorough, having extended over two years, and the records of tests taken over this period show, as is stated in the pamphlet, an increase of 23½ per cent in favor of the chain-driven machine over a similar belt-driven one.

AN AMERICAN MECHANIC IN EUROPE—5.

A SERIES OF LETTERS FROM OSKAR KYLIN ON THE EDITORIAL STAFF OF MACHINERY.

ASKLANDA, SWEDEN, July 3, 1908.

Since writing the letter published in the July issue, dated at Paris, France, I have been through England and visited a number of the well-known machine tool builders, and other large manufacturing concerns. It can be said that, generally speaking, the commercial situation in England does not differ to any extent worth mentioning from the conditions in Germany. The replies from dealers and manufacturers are in agreement that the trade at the present time is dull, but many of the largest and best informed dealers in London and elsewhere see signs of improvement in trade all along the line. In the machine tool works which the writer has visited, the situation differs materially, even to so great an extent that one concern in Halifax reported itself as still being forced to work overtime to fill the orders, while another concern stated that it was almost entirely out of orders. This concern is working short time, and with part of its normal working force, and even then is occupied principally with stock. These two cases represent the extremes between which the true state of affairs is to be found.

The general situation in the works which are principally building large heavy machine tools, is that they are still working full time and with full force, but having only a few recent orders on hand, and not being able to secure many new orders, they fear a reduction of time or force will be necessary in the near future. On the other hand, the works making the middle-sized or smaller machine tools, as a rule have reduced their output to below the average. Mr. Cooper, with Messrs. Buck & Hickman, London, stated that their sales of machine tools amounted to about ten per cent of that of a year ago, but, inasmuch as the small tool business kept up well, the total amount of business done was about sixty per cent of that for a year ago.

The New Patent Law.

The new English patent law, of which mention has been made in MACHINERY, is now in force. A few prominent people have kindly stated their opinions to me in regard to the consequence of this legislation. Judging from their statements, there is general satisfaction with the law and its probable effect on manufacturing industry. The opinion expressed is that the various branches of Great Britain's manufacturing will be benefited by the new law, that work will be obtained for a larger number of people because of the new lines of manufacturing established to conform to its requirements, and that the buyers or consumers will reap the benefit of a keener and more highly developed competition. At first glance, it appears that the new law would cause some damage to foreign patent holders or industries that export to England, but so far as the American machine tool industry is concerned, it is not believed that the law will cause material harm. The American manufacturer of a patented American machine tool has gained advantage over the English manufacturer of the same class of machines, as regards workmanship, methods of manufacturing, etc. With the same effort and enterprise in the future as in the past, he surely will be able to keep ahead of the game, and American-made machines should continue to be bought in preference to English makes.

The Franco-British Exhibition.

The machinery section of the Franco-British exhibition, which is now in progress at Shepherd's Bush, London, is not so large or so well represented as many other sections of the exposition. On the French side, the attention is mainly drawn to the line of wood-working machinery. Very few metal-working machines are to be seen, and these are of no great interest. On the English side the showing is comparatively large, and a number of interesting machine tools are to be seen, although nothing radically new is exhibited. Outside of the machine tool exhibit, the gas engine section consisting of two- and four-cycle engines, and the textile machinery sections are the principal sections of interest to the engineer and mechanic.

Wages in England.

In my previous letters a few figures have been given on the wages paid mechanics in the countries visited, and for the sake of comparison the figures of England may have some interest. Messrs. Alfred Herbert, Ltd., Coventry, states that the average pay in its works is 5 shillings ($1.50) a day for skilled labor, and this wage appears to be a fair average for other concerns. One Halifax concern reported that its pay for skilled labor varies from 32 to 42 shillings a week, which makes practically the same average.

Shop Notes from Machine Tool Building Works.

In my notes from Germany, it was remarked that the German machine tools, generally speaking, have the characteristics of being heavier and more solidly built than American machine tools. This is noticeable in a still greater degree in English machine tools, these being more heavily designed and more liberally dimensioned, even than German tools. The average Britisher likes a machine tool that looks very strong and rigid. This fact probably should be credited for the not unusual occurrence of finding machine tools in English works of great age, sometimes up to forty or fifty years, which are still doing work sufficient to warrant continuing them in service in this age of high-speed heavy duty machines. One feature that is sometimes found in English heavy duty lathes, which lends rigidity, is that of having the head-stock cast in one piece with the bed. This practice, however, is not followed to a large extent now, because of the greater manufacturing cost as compared with the separate head-stock construction.

One of the best known of all the English machine tool works is that of Messrs. Alfred Herbert, Ltd., Coventry. The growth of this establishment has been rapid and continuous. When it started twenty-one years ago it employed but twelve men, and now it employs not less than 1,500 throughout the works. The original plant is located in Coventry. Extensions required to accommodate the rapidly growing business, long ago covered the available space, and the company was forced to build an additional plant on a plot removed about two and one-half miles from the old works. The new plant is located at Edgwick where the foundry and pattern stores are already built. In laying out and equipping the new works, the company utilized its experience gathered throughout the years spent at the old plant, and in view of the past rapid growth, it has deemed it advisable to provide for large extensions in the future. The machine shop, in fact, has been designed so that it can be multiplied by four should trade conditions warrant such extensions. Provisions have also been made to extend the various auxiliary departments to a corresponding extent. (See MACHINERY, March, 1907.)

The chief machines manufactured in the new works are milling machines of both vertical and horizontal types, sensitive drills, cutter grinding machines and milling attachments. The old works are principally devoted to the manufacturing of turret lathes, automatic screw machines, and gear-cutting machines. The line of turret lathes comprises principally the hexagonal turret lathe for bar work, the combination turret lathe for chuck work, and the capstan lathe. The turret lathes are equipped with new roller back rests which have the advantage over the common back rest usually provided with turret lathes, of making heavier cuts and higher work speeds possible. With the heavy type of Herbert hexagon turret lathe a bar can be reduced from two inches diameter to one inch diameter at the rate of six inches per minute. It was interesting to note in these works to what large extent special jigs and fixtures are employed in order to reduce manufacturing cost. A feature of the manufacturing practice, of technical interest as well as indicative of the care that is taken to obtain good workmanship, is that all heavy castings such as lathe beds, milling machine columns, heavy slides and tool rests are stored for about six months after having been planed or milled. Then they are sent to the erecting department for assembling. The claim is made that the storing of the castings is necessary because they change shape slightly during the seasoning period. This change of shape is very slight, however, and does not necessitate re-machining when the parts are taken from the store-

room to the assembling department. Scraping is sufficient to correct the change of shape.

Generally speaking, the English machine tool builders do not specialize on one or a few machines, but build a multiplicity of types and sizes. Some concerns go so far in this direction as to build a complete line of machine tools from the smallest up to the largest sizes, but, of course, this complete line does not include any but the types that are most commonly found in average machine shops. Even in small and middle-sized shops where specialization is of, perhaps, greater importance than in the larger works, this condition holds true. A large establishment can afford to carry a larger number of sizes and types than the smaller works, and still employ the labor-saving devices and methods that are employed in specialized manufacture. There is safety in building several types of machines as compared with specialization on one, because at one time some one machine tool is in demand in the market, and at another time another machine tool will have a call, and so on. When a concern has only one type, it feels the fluctuations of the market more, while in the other case the fluctuations of the market for one type will, to a certain extent, be balanced by the fluctuations of the other types. This is probably the chief reason why English manufacturers do not specialize.

The small and middle-sized concerns seldom make any machines for stock, but as a rule build only to order. It seems to be a very common practice to build machines in batches of two, four, or six at a time, and only occasionally in such large batches as twelve. To fill out a batch, sometimes one or two machines are made extra for stock in case the order is not large enough.

An interesting middle-sized concern which the writer visited is H. W. Ward & Co., Birmingham. Some time ago this concern set out to supply a full line of machine tools, but it has dropped the manufacturing of a few types and sizes which it intended to build. The firm still makes a large variety of machines, engine lathes, turret lathes, milling machines, etc. A short time ago the concern took up the manufacture of a few types of grinding machines, and it has now placed on the market an internal grinding machine with a special feature. The machine is designed especially for the grinding of bushings and similar parts, and is equipped with two grinding wheels. The principal wheel for internal grinding is mounted according to the common practice, while the second one for grinding the ends of the part is mounted on a slide behind the internal grinding wheel spindle. The object, of course, is to be able to face the end of the bushing at the same setting at which the internal grinding is done.

One of the largest centers of machine tool manufacture in England is Halifax, and besides size, it offers many features of interest to the American visitor, one being that it is typically English. In explanation of this statement, we might say that the larger machine tool works on the Continent and in England cannot be said to be typically representative of the countries in which they are situated. The lay-out of the works and the methods employed are generally in accordance with the best internationally recognized practice. The practice that is typical of a country's work is to be found in the middle-sized and smaller shops. Generally speaking, this is so, but, of course, it does not always hold true. The machine tools made in Halifax are of the heavy English design to which reference already has been made. Regarding the quality and workmanship, the product varies from the good average machines which will satisfy all requirements of the ordinary up-to-date machine shops, down to the cheap grades of machines which are only good enough for the small repair shops, and whose principal recommendation is low price.

The manufacturers of the low class of machinery and tools are, one can say, without exception, small concerns with work laid out without system, equipped with old-type cheap-class tools, and evidently lacking all modern methods and devices. It seems impossible that these small old-fashioned works, in this age of highly developed labor-saving machines and methods, could still continue to do business enough to keep alive and pay interest on capital invested. About the only reason that the writer has been able to assign is that there is not enough competition in the cheap class of machinery. There is quite a large demand for cheap tools from small repair shops and small jobbing shops having a limited amount of capital, but this demand is neglected by the ordinary manufacturers. A concern employing modern methods and machinery goes in for the manufacture of high-class machinery and it does not care about the demand for the cheap machines. The consequence is the existing condition under which the buyer of cheap machinery has to pay a much higher price than should be the case were modern methods employed for manufacturing this class of tools.

J. Butler & Co., Halifax, is one of the middle-sized concerns making a good heavy class of machinery. This concern is engaged in the manufacture of nearly all kinds of machine tools from the small size up to the largest size, but is principally pushing its line of planers, shapers and slotting machines. Another concern in the same class, but somewhat smaller, is John Stirk & Sons, Ltd., Halifax. One of the few concerns that have started out to specialize to a large extent is Messrs. William Asquith, Ltd., Halifax. About eight years ago this concern devoted itself to building drills and boring mills. Its line of radial drills is very large, and contains types ranging from the smallest size for use of tool-makers, up to the largest size used by large ship-building concerns. The company usually builds the machines in lots of three throughout all departments, only occasionally making a larger number at a time.

Probably the oldest and at the same time the largest of the concerns in England, is that of W. G. Armstrong, Whitworth & Co. This concern owns several large plants for ordnance work, ship-building, engine building, machine tool manufacturing, etc. The chief work executed at its plant at Openshaw, Manchester, consists of ordnance work, armor-plates machine tools and small tools. The line of machine tools is large and the concern claims to build as complete a line as it is possible for any concern to build. Of special interest is its line of heavy machine tools for ordnance work, especially for planing and cutting off armor plates. Its heavy armor plate planer has not less than eight tools cutting at a time. To save the time ordinarily lost on the return stroke, the planer is built to cut both ways. The principle of the reversible tool-holder which is used on smaller planers here, could not be employed on this large planer on account of the great strength and rigidity required. Instead, the tool-holders are made to carry two tools, each of which is arranged so that one tool cuts in one direction while the other cuts with the table traversing in the opposite direction. The work remains stationary because of its heavy nature, while the two housings and cross-rails are traversed back and forth by heavy screws. (See MACHINERY, June, 1908, for photographs of pit planers used on armor-plate, etc.) The principle of using double tool-holders with two tools, one cutting one way and the other the other way, is applied to nearly all of the Armstrong armor-plate working machines and is a feature of much time saving.

It was of much interest to the writer to see planers fifty years old still in use in these works. These planers are of small size, built along common lines for small planers, that is, with reciprocating work table and fixed housings. A feature of interest is the reversible tool-holders which enable the planer tool to cut both ways. There is no quick return of work. A mechanism operated at each reverse of the table, reverses the tool-holder and the tool. The design is necessarily somewhat weak and it cannot be used successfully on heavy duty planers.

Another old established concern is Messrs. Smith & Coventry, Salford, near Manchester. This concern now employs about 500 men, and is principally pushing its lines of milling machines and drills, although also engaged in making boring and turning mills, ordinary engine lathes, gear-cutting machines, etc. In building sensitive drilling machines, careful attention is paid to the reducing of friction by means of ball bearings and anti-friction devices. Much attention is also paid to the rigidity of construction and with their heavy-duty drills a rate of drilling speed of 12 inches a minute has been obtained when drilling 1-inch holes.

Regarding the system of manufacture, all standard parts such as screws, studs and small parts that can be used for

several sizes of machines, are made in quantities sufficient to last six months or more. When the store for a certain size of stud is exhausted, an order for new studs is placed, sufficient to last another six months, and so on. As a rule large machine parts are not made for the store, but only to order.

Regarding the use of automatic labor-saving machinery in the machine tool works, it can be said that not so much automatic machinery is used in England as in America. Many English manufacturers claim that they can do better with less automatic machinery. For example, take the case of a machine tool manufacturer making his own supply of studs. The Englishman's view of the situation is that a cheap man, or even a boy can easily be put on this work on a hand-operated turret lathe, and will soon acquire skill in the particular operations involved, and consequently will soon reach high efficiency. There is no expensive machinery and no large capital invested. On the other hand, with automatic machinery, a high-priced man has to be employed for running it, and, in addition, there is a higher rate of interest on the capital invested. In a middle-sized machine tool shop which does not specialize, there is not sufficient work to be done on automatic machinery to keep the highest number of automatics that one man can manage efficiently, running all the time. When there is not sufficient number of automatics employed, and not sufficient work obtainable to keep the machines running but a small part of the time, the cost of labor becomes higher than with hand-operated machinery.

In the works of Messrs. Mather & Platt, Ltd., Salford, near Manchester, where gas engines, steam turbines, pumping machinery, textile machinery, electric motors, etc., are built, an interesting kink for cutting long screws was noted. An ordinary lathe is used for the purpose, the carriage being operated by a feed-screw as in ordinary thread-cutting practice. In addition to the common mechanism of all thread-cutting lathes, there is a device on the carriage which automatically reverses the traverse of the carriage, and at the same time operates the tool slide at the end of the screw, moving the threading tool backward to clear on the return, and advancing it into the work at the beginning of the cut. The depth of the cut can be regulated by hand when desired. The feed is automatic and at the back of the lathe a reversing bar is provided carrying two adjustable stops by which the reversing mechanism and tool slide are operated. Provisions are made for quick return of carriage. There is no automatic stop to stop the tool slide when it has reached the correct depth, the workman having to watch the work and stop the machine by hand when a screw is finished. With the exception of this omission, the machine works automatically. One man can operate three machines when cutting screws. [These lathes are evidently adapted to cut screws automatically in about the same manner as performed by the automatic threading lathe built by the Automatic Machine Co., Bridgeport, Conn.] —EDITOR.

Messrs. Hulse & Co., Ltd., Salford, near Manchester, a middle-sized concern, is putting its efforts into building large heavy machine tools for ordnance work, turbine shops, shipbuilding shops, etc., its works being equipped for just this kind of machine tool building. At the present time it is, to a large extent, engaged in machinery for the ordnance trade.

Another concern engaged in the same line of machine tool building is Messrs. Craven Bros., Manchester, but this concern is also building a few smaller sizes of machine tools. At the present time it is principally engaged on a large number of heavy machine tools for ordnance work, thus to some extent indicating the activity of Great Britain in her defensive and offensive preparations for war.

* * *

MISCELLANEOUS FOREIGN NOTES.

GERMAN LOCOMOTIVE EXPORTS.—Last year Germany exported 552 railway locomotives, and 395 smaller locomotives for industrial purposes, up to 10 tons each, together with 3,605 tons of locomotive parts. Italy was the principal customer for German locomotives, but large shipments were also made to France, Chili, Argentina, and Brazil.

GERMAN SHIP BUILDING PROFITS.—While the English ship building yards have experienced considerable difficulty during the last part of the last year and during the first part of the present year, one of the chief German ship building yards, the Vulcan, of Stettin, does not seem to be financially embarrassed by the present depression, a dividend of 14 per cent having been declared for the last year. The company has reduced the working hours from 10 to 9½ hours a day.

RUSSIAN STEEL TRUST.—Rumors have long been circulated about the plans for the formation of a Russian steel trust. This trust or union has now become an established fact. The syndicate comprises the works in Southern Russia, and will control about 65 per cent of the aggregate steel production of the country; it will also be the owner of important ore deposits and coal mines. The working capital comprises about $75,000,000, and the trust is financed by Belgian and French financiers.

ELECTRICAL INDUSTRIES IN GERMANY.—Messrs. Felten and Guilleaume-Lahmeyer, of Mülheim-on-Rhine, Germany, one of the most important of the German electrical companies, state in their annual report, that the past year was one of exceptional activity. During the year the company obtained orders for dynamos amounting to total capacity of 500,000 horsepower. The capital of the company is nearly $14,000,000, and the dividend declared was 10 per cent. It is mentioned that the new patent law in England is likely to influence the German electrical trade.

BRITISH TRADE CONDITIONS.—The British machine tool trade is likely to be seriously affected for some time to come by the conflict in the ship-building trades between employers and employes, on account of which some works have closed. The difficulty is caused by the resistance of the employes to a reduction in wages. Unless an early settlement of the differences can be arranged, between 50,000 and 60,000 men will be affected directly in the ship-building trades, and a great many more indirectly by the stagnation in other trades which will necessarily follow.

SHIPBUILDING IN GREAT BRITAIN.—The conditions in the British shipbuilding trades are rather discouraging. The tonnage of vessels launched in Scotland during the month of May was exceedingly small. On the Clyde 25 vessels of only 11,072 tons were launched, as compared with 30 vessels of 43,670 tons in April this year, and 40 vessels of 62,246 tons in May last year. The comparatively large number of vessels launched is accounted for by the number of barges, tugs, and other small craft included. For the first five months of the year the total tonnage launched was 114,826 tons, as compared with 242,392 tons for the same months last year, a decrease of considerably more than 50 per cent.

THE GERMAN IRON INDUSTRY.—At a recent meeting of the Union of German Iron Masters it was stated that while there had been a falling off in the business since last December, the depression was less pronounced in Germany than in other countries. Rather than to dismiss a large number of men, the iron industry had disregarded the trade requirements of the moment, and had continued its production to a certain extent, and kept the surplus material in stock. The advantage of the quiet time now prevailing after the past period of high tension was appreciated, inasmuch as it gave many works an opportunity of completing and repairing their plants. The basis for future development is considered sound.

TRADE CONDITIONS IN SWEDEN.—According to a report read at the last quarterly meeting of the Union of Swedish Iron Masters, the general business depression has made itself felt in the Swedish iron market, and the exports of bar iron show a decline of 25 per cent during the first three months of this year, as compared with the same period last year. Many of the works, however, have orders since last year which have not yet been filled, and these will keep them busy for several months. The number of blast furnaces going was 114 as against 120 for the same period last year. The machine tool and general machine building industries seem not to have been affected very much by the general depression. Several important firms are extending their works, and as soon as the present uncertainty in business becomes settled the demand for machine tools is likely to be considerable, as many extensions to shops now being built will then have to be equipped.

WORK OF THE U. S. GEOLOGICAL SURVEY IN CONSERVING NATURAL RESOURCES.

The United States Geological Survey has been an important factor in the movement for the conservation of our natural resources, for many years, and while its work has been to a certain extent altruistic in that the immense benefits will come to the generations of the future, it has already saved millions of dollars' worth of resources for the people of to-day. The Survey's geologic and topographic work have resulted in an inventory of the natural resources, a stock-taking such as a prudent manufacturer takes once a year. This has disclosed the waste that has been going on, and led directly to the conference of the governors of the States in Washington in May. The study and classification of the coal deposits of the United States and especially those on the public domain, have established the value of these coals and have prevented the thoughtless disposal of the 50,000,000 acres of government coal lands. The values of the mineral deposits on government land have been approximated to such an extent that it will now be impossible to dispose of them without getting a fair return.

While there have been many immediate benefits from the topographic work and a study of the water resources of the country, their value to the people will be many fold greater in the near future. Without an accurate topographic survey of the land and water, the contemplated improvement of the waterways, the drainage of swamps and the great irrigation projects would be impossible. The work already done along these lines will push these big improvements forward several years and result in the saving of much money.

In its endeavors to check the great waste of the natural resources, the Survey a few years ago extended its field by taking up the subject of the utilization of the fuels of the country and so fruitful have been these investigations that there is every promise of a saving of millions of dollars within a short period. These investigations appeal directly to the manufacturer, the business man and the consumer, for they show him how to realize immediate economies he never dreamed of before.

Authorized to test the fuels owned by or for the use of the government itself, the Survey has made a number of discoveries of the greatest importance to the entire people. At the government's fuel-testing plant, it has been shown that the gas engine is capable of generating from two-and-one-half to three times as much power, using a given amount of coal, as can be obtained from a steam engine. This means, it is declared, that a 600 horse-power gas engine will save $5,000 a year in its coal bill over the same power steam engine, and that the saving on a 6,000 horse-power gas engine ought to amount to $72,000 a year.

The gas engine has also opened the way for the use of millions of tons of low-grade fuel, much of which has heretofore been thrown away as useless. The tests have shown that coals, practically valueless under steam boilers because of their high percentages of impurities, have in a gas producer generated sufficient power for the gas engine to render them of high commercial value. Coals as high in ash as 45 per cent have been used successfully in the gas engine.

In the West, where the supply of high-grade coal is inadequate, the low-grade lignites (the poorest form of coal) of North Dakota developed as much power when converted into producer-gas as did the best West Virginia bituminous coals when used under the boiler of a steam engine.

To the West, this discovery of the government scientists is of the utmost importance. It makes possible the introduction of cheap power and therefore the establishment of an industrial empire of immense proportions. There are many million acres of lignites in the West, an almost inexhaustible supply for fuel that, so far, has been practically useless, the people being compelled to send a great distance for their coal and pay big freight charges on what they used.

In the average steam engine to-day but 5 per cent of the coal energy is transformed into work. In the gas engine, this percentage of efficiency is 12½ per cent. The coal used in generating power in the United States last year amounted to about 300,000,000 tons. With the universal use of the gas engine, it is estimated that at least 100,000,000 tons of this coal could be saved.

In testing the efficiency of coals under the boiler of a steam engine, the Survey engineers suggest still another way to save the fuel. Recent experiments indicate that boilers ought to perform two or three times the work they do now. In New York City, a certain large corporation has almost doubled the capacity of its power plant by placing furnaces in the rear of its boilers as well as the front. This was done at a saving of several hundred thousand dollars, as it would have been necessary to purchase additional land held at a high figure to carry on the work. The tests of different coals under the steam boiler at the government plant have also showed the possibility of increasing the general efficiency of hand-fired boilers 10 to 15 per cent over ordinary commercial results.

The Survey is also engaged in a general analysis of the coals of the country. These analyses have resulted in the government purchasing coal on definite specifications based upon its heating value. Under this system a better grade of coal and coal better adapted to the types of furnaces in the government buildings has been obtained without any increase in cost, which in itself is a saving to the government. These investigations, by suggesting changes in equipment and methods, are also indicating the practicability of the government's purchasing cheaper fuels such as bitmuinous coal and the smaller sizes of anthracite, instead of the more expensive sizes. With new boilers in the heating plant of the State, War and Navy Building in Washington, $15,000 is now being saved each year in the coal bill for this building alone. Many power plants are now buying fuel on specifications and have obtained increased efficiency as a result of the government's investigations. These tests of the coal will aid manufacturers, wherever situated, to save money in the purchase of coal, for they will enable them to learn where they can buy coal that is best suited to their purpose.

The government has found still another way of conserving the fuel resources in the briquetting of coal. The investigations show that in the near future the great quantities of waste coal seen about every mine and the low grade coal that is now being left in the mines, will be utilized in the generating of power and for locomotive power and domestic heating. Successful tests of briquets were recently made on two railroads. The briquets, which were made from the slack of high-grade bituminous coal, showed an economy of 20 per cent over the same lump coal, not taking into consideraton the cost of making the briquets.

At the government fuel-testing plant at Denver, Colo., investigations into the washing and coking of coal have been carried on for a year with much success. In the washery plant, it has been shown that coals were greatly improved by washing, at the nominal cost of from three to ten cents a ton. In recent experiments, the experts have succeeded in making coke out of several coals that have been regarded as non-coking. Of thirty-seven samples tested from the Rocky Mountain region, all but three produced good coke, though a number of these were considered non-coking coals. When the metallurgical interests of the West are noted, the importance of these investigations will be realized.

* * *

PERSONAL.

J. B. Doan, vice-president and general manager of the American Tool Works, Cincinnati, O., returned July 17 from a business trip in Europe.

S. E. Balcom has been appointed chief engineer of the power, light and heat service of the Worcester Polytechnic Institute, following the resignation of Noah Ashwood.

C. A. Parsons, the inventor of the Parsons steam turbine, received, on June 11, the honorary degree of doctor of engineering, at the Liverpcol University.

Dyer Smith, formerly an associate editor of MACHINERY, and later an examiner in the Patent Office, Washington, D. C., has graduated in a course of patent law, and is now employed as a patent attorney by Mr. Thomas A. Edison, Orange, N. J.

Carleton A. Reed, recently professor of mechanical engineering at the New Hampshire State College, has been appointed to fill the position vacated by Prof. George I. Rockwood, as professor of steam engineering, at the Worcester Polytechnic Institute.

George I. Rockwood, who for the past two years has occupied the chair of professor of steam engineering, at the Worcester Polytechnic Institute, has resigned. It is Professor Rockwood's intention to take up his entire time with the Worcester Fire Extinguisher Co.'s business, with which he has been connected for some time.

J. W. Lutz, since 1880 assistant superintendent and general foreman of the O. S. Kelly Co., Springfield, Ohio, has resigned to become superintendent of the Duplex Mill and Mfg. Co., Springfield, Ohio. This concern has bought the grinding business of the O. S. Kelly Co. and will extend its business to include other products. Mr. Lutz is a stockholder in the new company.

Walter M. Nones is here from London, England, to get in touch with manufacturers of specialties in machinery, tools and allied lines, who care for European trade, either for the purpose of securing agencies or licenses of patents. Mr. Nones informs us that he has placed some important lines abroad and would like to hear from manufacturers who are interested.

L. Moulthrop, who has been connected for the past thirty years with the New Haven Mfg. Co., New Haven, Conn., manufacturer of machine tools, recently resigned as secretary and treasurer, still remaining as director. William H. Brown, who has been with the company a long time, succeeds Mr. Moulthrop as secretary and treasurer, and J. Judd continues as superintendent.

* * *

OBITUARY.

Charles H. Dale, of New York, died at his summer home in Larchmont, N. Y., July 18, from heart disease, after a brief illness. Mr. Dale was born in 1852. He was prominent in the rubber manufacturing business, being president and director of the Peerless Rubber Manufacturing Company, the Mechanical Rubber Company, the Morgan & Wright Company of Detroit, the New York Belting & Packing Company, the Rubber Goods Manufacturing Company, the American Commerce Company, and director in other rubber companies.

George H. Daniels, for many years general passenger agent of the New York Central R. R., died at Lake Placid, New York, July 1. He was born in Hampshire, Ill., 1842, and was in railroad service one way or another since he was a young lad. He entered the service of the New York Central in 1886, and in 1889 became general passenger agent. He doubtless was the best-known passenger agent in the world. His advertising methods were unique, and the literature issued was the most interesting issued by any railway. Mr. Daniels retired from active service of the New York Central May 1, 1907.

* * *

NEW BOOKS AND PAMPHLETS.

THE HEWITT CORRESPONDENCE SYSTEM. By W. C. Holman. 38 pages, 4½ x 6 inches. Published by W. C. Holman, Chicago, Ill.

This booklet describes a system of correspondence, devised by Mr. Frank L. Hewitt, of the National Cash Register Co. It outlines a method of formulating letters and numbering paragraphs by which the correspondent can indicate to a stenographer the letter to write for any given condition likely to recur in correspondence, thus saving much valuable time and securing the maximum beneficial results that can accrue from a well-conducted business correspondence system.

CURVES FOR CALCULATING BEAMS, CHANNELS AND REACTIONS. By Sidney Diamant. 38 pages, 7 x 10 inches. Published by the McGraw Publishing Co., New York. Price, $2.00.

As indicated by the title this book was prepared to save time in structural designing by using the graphical process. The graphic method greatly facilitates the economic design of steel floor beams for various intensities of loading, and twenty-five plates for loadings of 80 pounds per square foot, up to and including 500 pounds per square foot for various lengths of span, and widths, center to center of arches, are included, these being the principal part of the work.

DESIGNING METHODS; REINFORCED CONCRETE CONSTRUCTION. 76 pages, 4½ x 8½ inches. Published by the Expanded Metal and Corrugated Bar Co., St. Louis, Mo.

This pamphlet is No. 2 of Volume 1 of a series designed to educate engineers and others on the qualities of reinforced concrete construction. This issue is devoted to detailed design of a typical building made of reinforced concrete, in which the reinforcement is rectangular and with T-shaped beams. The pamphlet is highly technical, and will be found a valuable contribution to engineering literature on reinforced concrete construction.

DRAWING INSTRUMENTS; THEIR USE AND ABUSE. By Walter G. Stephan. 108 pages, 4¾ x 7¼ inches. 74 illustrations. Published by the McGraw Publishing Co., New York. Price, $1.00.

This book is intended as a guide for students and young draftsmen in the purchasing of drawing instruments, drawing boards, paper, T-squares, triangles, protractors, etc. It lists a complete drafting equipment and describes the various instruments—triangles, scales, boards, T-squares, etc.—giving many valuable hints on the care and selection. It also touches on the slide rule, section liner, elliptograph, blue printing, drafting machine, planimeter, etc.

ORGANIZATION, EQUIPMENT AND OPERATION OF THE STRUCTURAL MATERIALS TESTING LABORATORIES AT ST. LOUIS, MO. By Richard L. Humphrey and Jos. A. Holmes. 84 pages, 6x9 inches. Illustrated. Published by the Department of the Interior, U. S. Geological Survey, Washington, D. C.

This account of the organization, equipment and operation of the structural materials testing laboratories, at St. Louis, Mo., is bulletin No. 329, and is intended to give a comprehensive account to the public of the various activities of this important part of the government's experimental work for the improvement of industrial conditions.

SOME THINGS MANUFACTURERS SHOULD KNOW ABOUT COAL. By E. G. Bailey. 10 pages, 6 x 9 inches. Published by Arthur D. Little, 93 Broad St., Boston, Mass.

This paper is No. 3 of a series of contributions to engineering chemistry made by the members of the staff of Arthur D. Little's laboratory, and was presented at the annual meeting of the National Association of Cotton Manufacturers, Boston, Mass., April 16-17, 1908. The object of the paper is to educate coal users in regard to the qualities of coal, what coal is most economical to burn, and how the highest percentage of the heat energy may be converted into useful work. No charge is made for individual copies for these pamphlets.

ADDRESSES DELIVERED AT THE INSTALLATION OF W. F. M. GOSS. 59 pages, 6 x 9 inches. Published by the University of Illinois, Urbana, Ill.

This pamphlet is a program of the installation of W. F. M. Goss, Dean of Engineering, at the University of Illinois, February 5, 1908, and includes addresses on "Significant Events in the History of the College of Engineering," by Ira O. Baker; "Standing of the Technical Graduate in the Engineering Profession," by Wm. L. Abbott; "The Value of Engineering Research," by Robert W. Hunt; "The Need of Graduate Courses in Engineering," by Willard E. Smith, and "The State College of Engineering," by W. F. M. Goss.

PRACTICAL PERSPECTIVE. By Frank Richards and Fred H. Colvin. 56 pages, 5½x8 inches. Published by Norman W. Henley & Son Publishing Co., 132 Nassau St., New York. Price 50 cents.

This little work on drawing, explaining the principles of isometric perspective and the use of isometric paper, has just been issued in the third edition. It illustrates how to make all kinds of mechanical drawings in perspective, so that any mechanic unfamiliar with reading ordinary drawings can understand the shape and purpose of the parts illustrated. It will be found useful to mechanical draftsmen otherwise, as it frequently is advantageous to make "pictures" of parts which will show in one view what ordinarily requires three or more views to show and then in a way intelligible only to those who have learned to read drawings.

SLOW BURNING OR MILL CONSTRUCTION. 28 pages, 9¼ x 11 inches, and 8 folding plates. Published under the direction of the Boston Manufacturers Mutual Fire Insurance Co., 31 Milk St., Boston, Mass. Price, 25 cents.

This pamphlet is report No. 5 and is of the third edition, having been revised in accordance with the accepted practice of to-day. The pamphlet will be found of great value to all contemplating the construction of new shops and factories, or the reconstruction of old buildings with a view to improving their fire-resisting qualities. The great loss annually sustained because of mill and factory fires makes the problem of reducing fire losses of the greatest importance to all, and this pamphlet is recommended to students of economics, as well as to manufacturers.

AIR BRAKE CATECHISM. By Robert H. Blackall. 380 pages, 5 x 7¼ inches. Illustrated. Published by Norman W. Henley, & Son, 132 Nassau St., New York. Price $2.00.

This work is recognized as a standard treatise on the air brake, and its large circulation is indicated by the fact that the book in review is of the twenty-third edition. It treats of the equipment manufactured by the Westinghouse Air Brake Co., including the No. 5 and No. 6 E. T. locomotive brake equipments, the K quick-service triple valve for freight service, the cross-compound air pump and the operation of all parts of the apparatus in detail. The subject is handled in the well-known catechism style; over 2,000 questions and answers are required for presentation. The illustrations include a number of large folding plates, which show clearly the details of the apparatus, and their relations to one another. The work is recommended to all interested in air brake theory and practice.

BOOK OF THE ECONOMIZER. 159 pages, 6 x 9 inches. Published by the Green Economizer Co., Matteawan, N. Y.

This book treats of the history and merits of the fuel economizer, taking up such topics as the absorption of heat by different parts of the boiler surfaces, the relative economy of boiler surface and economizer surface under various conditions, effects of oil fuel, high steam pressures and superheat on boiler economy, etc. One chapter is devoted to a novel explanation of the often observed fact that the economy from pre-heating boiler feed water is greater than would be found by calculating the ratio which the heat contributed by the feed water heater or economizer bears to the whole amount of heat required for evaporation. While primarily issued to advertise a proprietary apparatus, the subject is treated in a broad and comprehensive way, making a pamphlet of much interest and value to all interested in the economical production of power.

COMPARATIVE TESTS OF CARBON METALIZED AND TANTALUM AND FILAMENT LAMPS. By T. H. Amrie. 44 pages, 6x9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill.

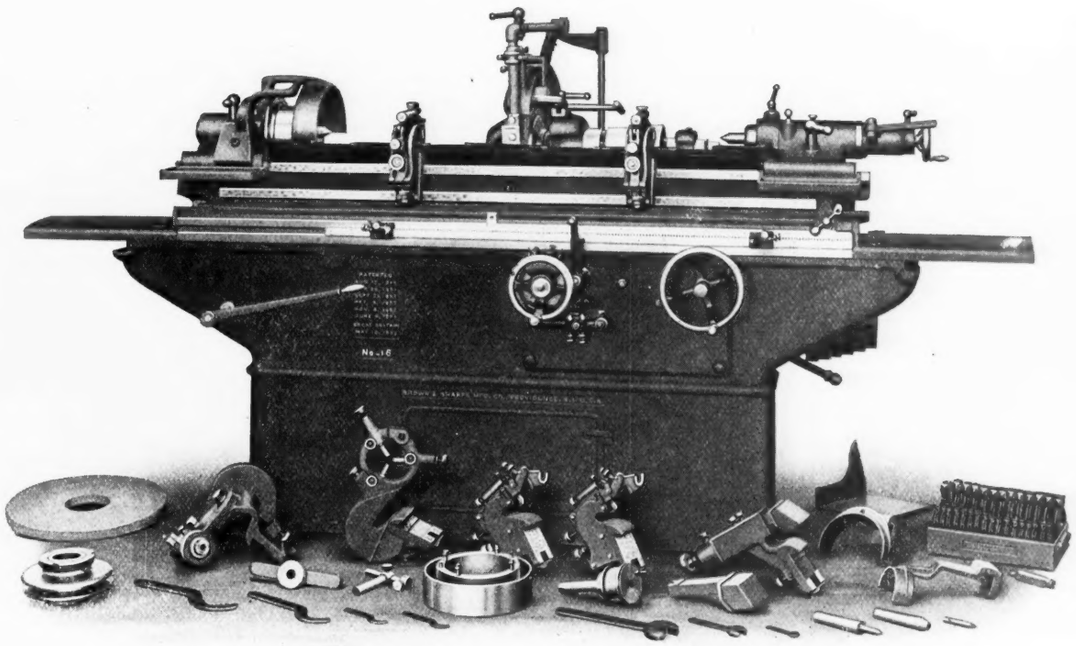
This bulletin, which is No. 19 of the series issued by the Experiment Station, records the results of tests made upon metalized carbon, tantalum and filament lamps in the laboratory of the electrical engineering department, with a view of bringing out the good points of each lamp, together with their faults, and offers help in the selection of the proper type for any particular purpose. The conclusion is that the tantalum and filament lamps cover adequately all the phases of incandescent lighting now covered by the three types. For a low power cost and rough usage the carbon lamp is best. For high power cost upon poorly regulated circuits the tantalum lamp is best, provided it is carefully handled.

IRON AND STEEL WORKS DIRECTORY OF 1908. 500 pages, 6 x 8½ inches Published by the American Iron and Steel Association, Philadelphia, Pa. Price, $12.00.

This directory gives a full list of the blast furnaces, rolling mills steel works, bloomaries and tin and terne plate works in the United States; also classified lists of wire rope mills, rail mills, plate steel mills, bessemer, open hearth, crucible and steel casting works. The present edition is the seventeenth and is corrected to March 1, 1908. The general plan of compilation adopted in the preparation of recent editions of the directory has been followed in the present edition.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.



Over Forty Years Grinding Experience

has taught us what is most essential, a knowledge of grinding requirements.

It has shown us the value of rigidity, the necessity of accurate workmanship in the construction of a machine and the advantage of convenience.

An absolute insistence upon these factors in the manufacture of

B. & S. GRINDING MACHINES

has made them what they are today, recognized standards for grinding.

A CIRCULAR DESCRIBING ANY OF THE GRINDING MACHINES SENT UPON APPLICATION.

Whenever possible the history of each plant has been preserved, giving the date of its erection, with all subsequent additions to the plant, changes in ownership, if any, etc. In view of the tremendous changes in ownership caused by the consolidation of plants under the ownership of the United States Steel Corporation, the importance of preserving an individual history of the various plants is apparent. The directory is one that can be heartily recommended to all interested in the information contained therein.

VOIDS, SETTLEMENT AND WEIGHT OF CRUSHED STONE. By Ira O Baker. 29 pages, 6 x 9 inches. Published by the University of Illinois, Urbana, Ill.

This bulletin, which is No. 23 of the series issued by the Engineering Experiment Station of the University of Illinois, records the results of experiments made to determine the proportion of voids in crushed stone, loaded by various methods in cars and in wagons; to find the amount of settlement during transportation; and to obtain the relation between the weight and the unit of volume of solid stone and of the same volume of crushed stone immediately after being loaded in various ways. All the results are summarized in a table which gives, for different sizes of crushed stone the coefficients by which to multiply either the weight of a cubic foot of solid stone or its specific gravity to get the weight of a cubic yard of crushed stone at the crusher and at the destination. This elaborate table is summarized in the following statement: The mean coefficient by which to multiply the weight of a cubic foot of solid lime stone to obtain the weight of a cubic yard of crushed lime stone, is as follows: For ¼-inch screenings, 15.5; for ½-inch to 2-inch stone, 14.6; and for 2-inch to 3-inch stone, 15.2. For trap rock corresponding methods are as follows: For ¼-inch screenings, 14.6; for ½-inch to 1½-inch stone, 13.5; and for ½-inch to 3-inch stone, 13.9.

CATALOGUES AND CIRCULARS.

GENERAL ELECTRIC Co., Schenectady, N. Y. Bulletin No. 4590, describing self-starting device for alternating current motors.

H. G. OSBORNE, 74 Cortlandt St., New York. Catalogue of Osborne's extension drills for drilling holes in brick walls.

PRATT & WHITNEY Co., Hartford, Conn. Catalogue illustrating and describing a spline milling machine, a machine for slot milling, cutting splines, key-ways, grooves, etc.

HARDINGE BROS., 1034 to 1040 Lincoln Ave., Chicago, Ill. Leaflet illustrating the Cataract precision bench lathe outfit No. 3, and catalogue illustrating the Beyer single record watchman's portable clock.

ESTEP & DOLAN, Sandwich, Ill. Catalogue of hand bending tools, for forming eyes, hooks, rings, hinges, staples, chain links and other parts made by the blacksmith.

BURKE MACHINERY Co., 1837 Thirty-fifth St., Cleveland, O. Leaflet illustrating and describing the Burke cold saw, and the Burke No. 3 and No. 4 bench milling machine.

CROCKER-WHEELER Co., Ampere, N. J. Bulletin No. 105, superseding Bulletin No. 88, illustrating and describing polyphase induction motors, made in sizes from 15 to 250 H.P.

SKINNER CHUCK Co., 94 N. Stanley St., New Britain, Conn. 1908 price-list of independent universal and combination lathe chucks; also drill chucks, planer chucks, face-plate jaws, drill press vises and reamer stands.

EXPANDED METAL & CORRUGATED BAR Co., of St. Louis, Mo. Catalogue illustrating use of corrugated bar for reinforced concrete construction in factories, machine shops and other buildings.

BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa. Record No. 65 of Mallet compound locomotive, being a paper read before the Engineers' Club of Philadelphia, March 12, 1908, by Mr. Grafton Greenough.

BROWN HOISTING MACHINERY Co., Cleveland, O. Catalogue of hoisting machinery adapted to the use of artificial gas, coke and electric light companies, for the rapid and economical handling of coal, coke and other materials.

BAUSH MACHINE TOOL Co., 200 Wason Ave., Springfield, Mass. Leaflet descriptive of the Bocorselski turret tool-holder for lathes. This tool-holder is made in three sizes, and two styles, and may be used with the turret in either a vertical or horizontal position.

LUCAS MACHINE TOOL Co., Cleveland, O. A set of four cards, distributed at the recent Atlantic City convention of the Master Car Builders' and Master Mechanics' Associations, descriptive of the Lucas power forcing presses.

WHITING FOUNDRY EQUIPMENT Co., Harvey, Ill. Catalogue of cupolas, charging machines, bottom door hoists, electric travelers, jib cranes, air hoists, foundry ladles, tumblers and other equipment for the foundry.

GISHOLT MACHINE Co., Madison, Wis. Small catalogue of Gisholt turret lathes, vertical boring mills, universal tool grinders, horizontal drilling machines, double emery grinders, worm hobbing machines, gear testing machines and chucks.

HESS-BRIGHT MFG. Co., 2111 Fairmount Ave., Philadelphia, Pa. Catalogue descriptive of the Hess-Bright radial and thrust ball bearings. The catalogue illustrates applications to line shafting, automobiles, motors and dynamos, and machinery in general.

BLACK DIAMOND BORING MACHINE Co., Monongahela, Pa. Catalogue descriptive of special boring machine for boring locomotive rod brasses and rolling and compressing the babbitt lining. The machine can also be used for other purposes, such as drilling, tapping, reaming, etc.

ROBBINS & MYERS Co., Springfield, O. Bulletin No. 67, descriptive of the "Standard" motor. The bulletin illustrates the various styles of motors built and applications to sewing machines, grinders, buffing and polishing wheels, speed lathes, drill presses, pumps, blowers, fans, punch presses, linotype machines, printing presses, etc.

JOSEPH DIXON CRUCIBLE Co., Jersey City, N. J., has issued a little booklet of twelve pages on brushes for generator and motor commutators. The booklet gives valuable hints on the care of commutators, and some conclusions drawn from the results of tests made by Professor Albert F. Ganz, at Stevens Institute, Hoboken.

BANTAM ANTI-FRICTION Co., Bantam, Conn. Issue No. 2 of the *Bantam Anti-Friction Booster*, containing items of local interest, "hot shots," humorous paragraphs, and advertising the line of ball and roller bearings made by the company. This issue is published on pink paper, and is a unique specimen of advertising.

UNITED STATES ELECTRICAL TOOL Co., Cincinnati, O. Catalogue illustrating a complete line of electric hand drills, breast drills, electric-driven radial drills, electric-driven center grinders, bench grinders and surface grinders. The catalogue also demonstrates a few of the many uses of portable electric tools.

GENERAL ELECTRIC Co., Schenectady, N. Y., has just issued a small circular, No. 3664, descriptive of its new locking socket. This socket prevents the removal of an incandescent lamp by an unauthorized person. The peculiarity of this socket lies in the fact that the lamp is safe when the socket is unlocked. The socket and key are clearly illustrated in the circular.

WALKER GRINDER Co., Worcester, Mass. Circular descriptive of the Walker No. 3 plain surface grinder of the column and adjustable wheel head type. This machine has been specially designed to adapt it for finishing cast iron parts that are usually filed and polished, and in combination with the Walker magnetic chuck made by the same concern, it is exceptionally well suited for all kinds of surface grinding.

MARK FLATHER PLANER Co., Nashua, N. H. Bulletin No. 8, illustrating and describing 14, 16, 18, 20 and 24-inch Flather shapers, belt- and motor-driven. The bulletin also reproduces the analysis of the Flather shaper motion published in the March, 1907, issue of MACHINERY, in connection with the description of the shaper motion model built for the University of Michigan.

R. D. WOOD & Co., Philadelphia, Pa. Catalogue of hydraulic tools and machinery for steel works, boiler shops, bridge works and other plants requiring heavy bar shears, splitting shears, angle shears, punches, riveters, flanging presses, die presses, upsetting presses and other machinery required in the construction of boilers, bridges, cranes, etc.

AMERICAN BLOWER Co., Detroit, Mich. Illustrated sectional catalogue, No. 232, of "A B C" self-oiling steam engines, types A and E. This catalogue supersedes Bulletins 171, 181, 193, 194 and 206. It illustrates in detail the construction of the engine, showing the self-oiling features by which lubrication is assured to all working parts without the attention of the engineer, other than renewing the lubricant about once in three months, and filling the sight-feed cylinder lubricator.

LANDIS MACHINE Co., Waynesboro, Pa. Catalogue of pipe threading and nut tapping machinery and special threading machines. The Landis all-steel die-head, using a special form of chasers made from flat pieces of steel with threads milled their entire length on the flat side and adapted to cut either right or left-hand threads, is illustrated and described in detail. High speed steel dies are supplied for these die-heads to order. The high speed dies have the advantage of never needing to be re-hobbed or re-tempered.

GENERAL ELECTRIC Co., Schenectady, N. Y., has just issued a new bulletin on Thomson astatic instruments for continuous current switchboards. These instruments are extensively used, and have a reputation for reliability and accuracy regardless of external influence. They have no controlling springs, and their accuracy is not affected by changes in magnet strength. The damping effect in these instruments is produced by an aluminum disk moving in a magnet field, and the indications are dead beat. The bulletin describes voltmeters and ammeters of the feeder board and illuminated dial types, and gives complete dimension diagrams.

CUTLER-HAMMER MFG. Co., Milwaukee, Wis. Catalogue of push-button switch mechanism and push-button specialties. This electric push-button switch is of particular interest, on account of the simplicity and ingenuity of the design. Disregarding the casing, the switch mechanism consists practically of only three parts; first, a push bar extending clear through the switch, having its largest diameter in the center and having a conical shape from the center for some distance towards each end; second, a coil spring, which encircles the bar previously mentioned in such a manner that the axis of the spring forms a circle around the bar; third, a moving contact piece encasing the spring. The action of the device is simply this: when the bar is pushed, the coil spring rides up on the conical surface until it reaches the center, all the time preventing the contact piece from releasing until the spring has reached the central and highest part of the bar; then it suddenly contracts and moves swiftly along the conical shape on the other side of the highest point of the bar, carrying with it the moving contact piece. It is not possible to move the contact piece part way and let it slip back again, thereby drawing an arc which burns the contacts and eventually destroys them. The contact piece is either positively in contact or out of contact.

MANUFACTURERS NOTES.

WILLIAM HAHN, Chicago, Ill., maker of flexible shafts, etc., has changed his location from 220 Washington St., to his own building at 621-623 North Campbell Ave.

HOLBROOK-ARMSTRONG IRON Co., Racine, Wis., recently equipped its factory with three brass furnaces and an aluminum furnace at an outlay of $10,000. Crude oil is used for fuel.

GLOBE MACHINE & STAMPING Co., 974 Hamilton Ave., Cleveland, Ohio, has secured the shop rights from the United States Sherardizing Co., New Castle, Pa., for the dry galvanizing process, discovered by Sherard Cowper-Coles, London, England. Samples of articles to be sherardized may be sent to the company for an estimate as to the cost of the treatment.

CROCKER-WHEELER Co., Ampere, N. J. At a meeting of the directors, July 10, the following officers were elected: S. S. Wheeler, president; Gano Dunn, vice-president; A. L. Doremus, second vice-president; Gano Dunn, chief engineer; Rodman Gilder, secretary; W. L. Brownell, treasurer; J. B. Milliken, assistant secretary; G. W. Bower, assistant treasurer.

CUTLER-HAMMER MFG. Co., Milwaukee, Wis., manufacturers of electric controlling devices, will be represented on the Pacific Coast by Otis & Squires, 111 New Montgomery St., San Francisco, Cal. Mr. A. W. Vinson, who for several years has been connected with the engineering department of the Cutler-Hammer Mfg. Co., has been transferred to the office of Otis & Squires, where his services will be available to those having problems in electric control to be solved.

HAYES FILE Co., Detroit, Mich., has just purchased the entire plant of the Peacock File Co., located at Buffalo, N. Y., which was formerly the Maishoff Bros. factory, and has removed the machinery to Detroit. The company has been unable for some time to accept orders from new trade as it has been running its plant to full capacity to supply old customers, but after installing the Buffalo machinery it will increase the output about one-third.

L. S. STARRETT Co., Athol, Mass., has opened a warehouse at 36-37 Upper Thames St., London, England, where a line of fine mechanical tools, hack saws, steel tapes, etc., will be kept in stock. The London store will be a great convenience to British and Continental customers. It will save three to four weeks in getting goods and all goods will be shipped from London. Bills will be rendered in pounds, shillings and pence, and payments will be made in London. The London branch will be in charge of Mr. E. P. Barrus.

BROWN & SHARPE MFG. Co., Providence, R. I., will close its works from August 1 to August 30, inclusive, for annual vacation and repairs. On account of the unusual length of the vacation, special provision will be made to fill the reasonable wants of customers for special cutters and gears that may be wanted quickly. During the vacation the office will be open as usual, and orders for machine tools, machinists' tools, and cutters will receive the same attention as at other periods of the year.

ELECTRIC CONTROLLER & SUPPLY Co., Cleveland, Ohio, has changed its name to Electric Controller & Mfg. Co. The latter name more truly indicates the nature and scope of its business as evidenced by the following list of apparatus manufactured by the company: Controllers both manual and magnetic switch types for all purposes, lifting magnets, electric brakes, magnetic switches, solenoids, limit stops, arc welders, crane fittings, knife switches, flexible couplings, and the electric fault finder.

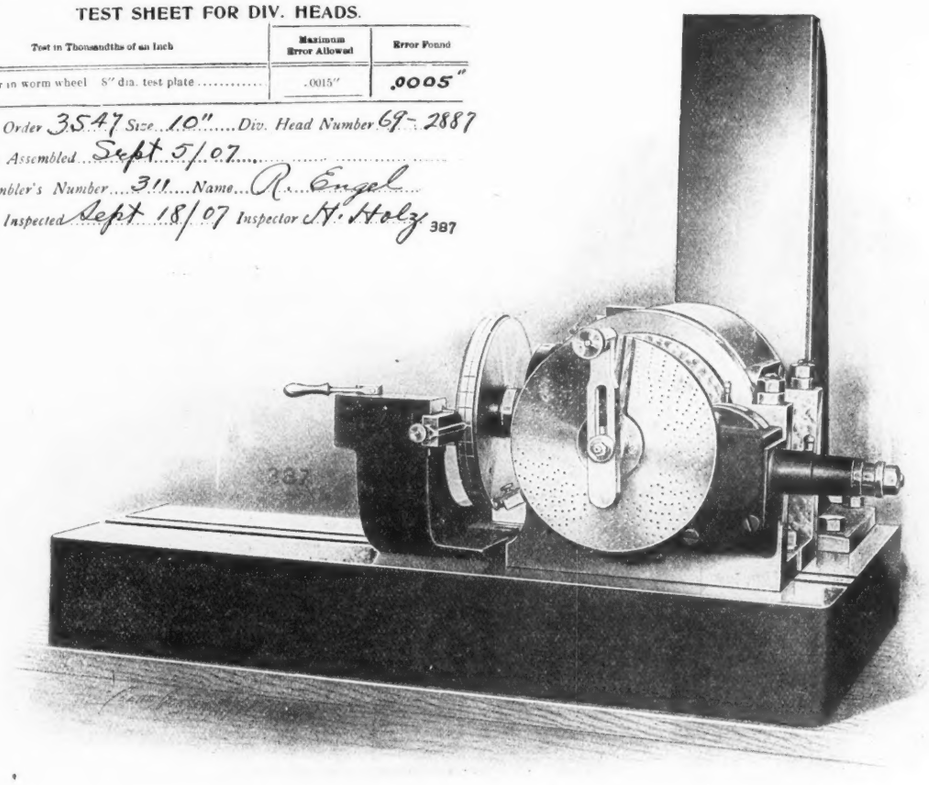
BECKER MILLING MACHINE Co., Hyde Park, Mass., has taken over the business of the Becker-Brainard Milling Machine Co. and will continue under the management of Mr. John Becker, whose practical experience in the design and development of the Becker Milling Machine has placed him among the foremost mechanics of the day. Many changes and improvements have been made in the plant, carrying out Mr. Becker's ideas and making it virtually the successor of the business which he started in Boston fifteen years ago and afterwards successfully built up in Fitchburg.

Cincinnati Miller Accuracy

TEST SHEET FOR DIV. HEADS.

Test in Thousandths of an Inch	Maximum Error Allowed	Error Found
Error in worm wheel 8" dia. test plate	.0015"	.0005"

Shop Order 3547 Size 10" Div. Head Number 69-2887
Date Assembled Sept 5/07
Assembler's Number 311 Name R. Engel
Date Inspected Sept 18/07 Inspector A. Holz 387



This shows how we test the Indexing Mechanism on our Dividing Heads.

Actual indexing is done on disks 8" in diameter by means of the apparatus shown which scribes hair lines across the carefully ground surface of the disks.

These are then measured for accuracy and a record made of the maximum accumulative error found in any quarter of the circumference of the disks.

The record shown herewith was drawn at random from a lot of 50.

It shows a maximum error of ½ thousandth on work 8" in diameter.

This is for all practical purposes, precision indexing.

We make our Indexing Worm Wheels on special generating machines which we designed and built in our own shop in order to attain this high degree of perfection.

Cincinnati Millers are as famous for their accuracy as for their productive capacity.

WE ARE MILLING MACHINE SPECIALISTS.

The Cincinnati Milling Machine Co.

CINCINNATI, OHIO, U. S. A.

European Agents—Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, Copenhagen and Budapest. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Paris, Turin, Barcelona and Bilbao. Charles Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.
Canada Agent—H. W. Petrie, Limited, Toronto, Montreal and Vancouver.

CONTENTS FOR AUGUST.

LAUNCHING A GREAT LAKES FREIGHTER. Ralph E. Flanders 837
THE DESIGNING OF MACHINE FRAMES. E. A. Fessenden.... 840
GEAR-CUTTING MACHINERY—8. Ralph E. Flanders..... 845
A GREAT PUBLIC CLOCK. Chas. A. Brassler..... 852
LOCAL HARDENING AND TEMPERING. William A. Painter.... 853
LARGE ROPE SHEAVE—CUT GEARS OF UNUSUAL DIMENSIONS 856
JIGS AND FIXTURES—5. Einar Morin..... 857
CUTTING LONG LEAD-SCREWS ON THE THREAD MILLING MACHINE 860
HELPS AND DONT'S FOR GRINDING..... 862
HOW TO HANDLE A FILE. W. A. Knight..... 863
SYSTEM FOR THE BLACKSMITH SHOP. James Cran..... 865
USING A SLIDE RULE FOR OBTAINING ANY ROOT OF NUMBERS. Hjalmar Fagerstrom..... 866
ITEMS OF MECHANICAL INTEREST..... 867
EDITORIAL 868
SIMPLICITY IN MACHINE TOOL DESIGN. W. T. Sears..... 869
FRICTION BRAKES..... 871
CLUTCHES 872
DIMENSIONS OF SCREW HEADS AND NUTS..... 876
HOW TO OBTAIN APPROXIMATE FRACTIONS BY THE METHOD OF CONTINUED FRACTIONS. Mitchell Dawes..... 877
MACHINE SHOP PRACTICE..... 878
DROP-HAMMER FOUNDATIONS..... 879
COMPARATIVE TEST OF ABRASIVE DISKS ON CAST IRON..... 880
SHEET METAL DRAWING. Frank E. Shailor..... 882
PULLEY BALANCING DEVICE. Allan..... 882
A HANDY FILING MACHINE. Ethan Viall..... 883
SMALL ACCURATE FACEPLATE WORK. Walter Gribben.... 883
FILE FOR MACHINERY'S DATA SHEETS. Samuel G. Aroscn.. 884
DOES PREMIUM WORK ALWAYS PAY? W. Alton..... 884
GRINDING FIXTURE FOR END MEASURE RODS. G. R. Richards 884
VALUE OF CO-OPERATION. Walter J. Bitterlich..... 884
READING THE SLIDE RULE ACCURATELY. C. H. Cornes..... 885
METHOD OF LEVELING A LINE SHAFT. Julian D. Page..... 885
METHOD OF ACCURATE DRILLING. Y. Ziegler..... 885
RACK FOR CHANGE GEARS. Wm. F. Groene..... 886
OBTAINING THE HEIGHT OF THE MIDDLE ORDINATE OF AN ARC. H. S. Quackenbush, Jr..... 886
SELF-OILING MACHINERY. A. L. DeLeeuw..... 886
EXTENSION ARMS FOR PLANING WIDE WORK. W. S. Leonard. 887
INFORMATION FOR CUTTING SPIRAL GEARS. L. H. Georger.. 887
PATENT RIGHTS IN TECHNICAL DESCRIPTIONS. J. G. Matthews 887
LAPS AND LAPPING. A. J. DeLille..... 888
PATENTS AND INVENTORS. H. Addison Johnston..... 889
A FEW HANDY KINKS. Vim..... 889
A SPECIAL DRILL CHUCK. W. Alton..... 890
ADJUSTABLE HOLLOW MILL. W. Alton..... 890
SHERARDIZING OR DRY GALVANIZING..... 890
HOW AND WHY..... 891
MODERN GERMAN MILLING MACHINES. Oskar Kylin..... 892
NEW MACHINERY AND TOOLS..... 893
AN AMERICAN MECHANIC IN EUROPE—5. Oskar Kylin..... 908

ELECTRIC WELDING PRODUCTS CO., Cleveland, Ohio, recently installed a grinding and finishing department equipped with Brown & Sharpe plain and universal grinders, special imported machines for spline milling or slot cutting and centering machines. This department will enable the company to turn out completely finished gas engine valves and valve stems and other similar work. It will finish gas engine valves made with nickel steel heads and carbon steel stems ground on both seat and stem and with slot, groove or thread cut or a hole drilled and the end hardened, thus making a product that is ready to be slipped into the engine in the assembling room.

WILMARTH & MORMAN CO., Grand Rapids, Mich., reports that the sales of "New Yankee" drill grinders for June, 1908, exceeded the volume of sales not only for June, 1907, but for every other month in the year 1907 with one exception. While the company appreciates this testimonial of recognition of the value of its machines, it is specially gratified by the fact that manufacturers are recognizing the need for mechanical appliances for grinding twist drills. It has taken many years of hard work to prove to mechanics the need of special machines for grinding drills and to demonstrate to them that machine-ground drills are far superior in efficiency to hand-ground drills, as usually done by the average workman.

COMING EVENTS.

August 18.—International Master Blacksmiths' Association Convention, at Cincinnati, Ohio. A. L. Woodworth, Lima, Ohio, secretary.

October 5-10.—First International Congress of Refrigerating Industries, Paris, France. J. F. Nickerson, 315 Dearborn St., Chicago, Ill., Secretary American Committee, will send circular and further information upon request.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

APPLICATIONS ARE DESIRED from shop men who believe that they would have ability as real estate salesmen, selling new farm lands. This is an exceptional opportunity to earn good money in your spare time and to work into a better paying line of business. Address Box 403, Madison, Wis.

DO YOU KNOW WHAT THE MACHINERY LEAGUE IS? Do you know what a friend in need is? The League was instituted by MACHINERY for the benefit of its active friends in the shops, and membership is limited to them. There are no dues. Write for information, giving the address of your works as well, to the Secretary, The MACHINERY League, 49-55 Lafayette St., New York City.

DRAFTSMEN AND MACHINISTS.—American and foreign patents secured promptly; reliable researches made on patentability or validity; twenty years' practice; registered; responsible references. EDWIN GUTHRIE, Corcoran Building, Washington, D. C.

DRAFTSMEN cannot know too much about shop practice—many of them know too little and are handicapped thereby. MACHINERY'S Shop Operation Sheets can help greatly. They are direct, definite and practical. The set now comprises 72 distinct operations. Write for pamphlet. MACHINERY, 49-55 Lafayette St., New York City.

FOREMAN.—For erecting heavy machine tools; must be experienced on accurate machine tool work, with ability to increase production and efficiency. State age, experience and salary expected. Box 182, care MACHINERY, 49 Lafayette St., New York.

FOR SALE.—Local hardening and tempering of tool steel by flexible cover or shield process. Patented in United States, Great Britain and Canada, patent pending in Germany. Shop rates or licenses for sale in United States, under patent No. 882,162, at reasonable rates, graded according to amount of benefit derived. The smallest die or machine shop can afford to use it. British and Canadian patents for sale outright. For further particulars and information address the patentee, WILLIAM A. PAINTER, 1515 Franklin St., N. S., Pittsburg, Pa.

H. VOGEL, Room 823, 112 S. Clark St., Chicago, 'phone Main 3777. Designer of any kind of machinery.

MECHANICAL ENGINEER of vast experience, as designer of special machinery, automatic and otherwise, also as superintendent of factory and toolroom, wants similar position. Address, Room 823, 112 So. Clark St., Chicago, Ill.

NEW PATENTS ACT.—A firm of engineers and merchants having warehouses and offices in London, Birmingham, Glasgow and Manchester, are prepared to take up selling agencies for machines and small tools. Apply to "Y. Z.," care MACHINERY, 49 Lafayette St., New York.

PATENTS.—H. W. T. Jenner, patent attorney and mechanical expert, 608 F Street, Washington, D. C. Established 1883. I make an examination free of charge, and report if a patent can be had and exactly how much it will cost. Send for circular. Member of Patent Law Association.

PATENTS.—Write now, Inventors, for "Patent Particulars." STERLING P. BUCK (Registered Attorney), 3118 Dillon St., Baltimore, Md.

SEND 30 CENTS for copy of Rocking Valves and Gears. Covers the subject fully. THE INDUSTRIAL MAGAZINE, Cleveland.

SUPERINTENDENT FOR OUR GAS ENGINE WORKS, able to organize a perfect shop system, get work out economically and accurately. An ordinary shop foreman or theorist will not do. Salary $1,800 upwards; chance for something else. Witte Iron Works Co., Kansas City, Mo.

TAPS.—Wanted, automatic machinery of modern design for manufacturing taps. Would buy patents of a perfect machine already running. Write to HEINRICH DREYER, Importer of American Machinery, Berlin, C. Kaiser Wilhelmstrasse 1.

THE RIGHT DATA SHEET, just when you want it, might be worth ten dollars, or even a hundred dollars, to you. There are now 360 6 x 9 pages of MACHINERY'S Data Sheets, and they are all right. You can get the complete set immediately under offer No. 4—MACHINERY, engineering edition, one year, and the complete set of Data Sheets, $3.00. Address MACHINERY, 49-55 Lafayette St., New York City.

USE OF FORMULAS and of Tables of Sines and Tangents, without a knowledge of Algebra or Trigonometry, is made easy to you by SHOP ARITHMETIC FOR THE MACHINIST, which is No. 18 in MACHINERY'S Reference Series fully described in a pamphlet sent free on request.

WANTED.—Agents, machinists, toolmakers, draftsmen, attention! New and revised edition Saunders' "Handy Book of Practical Mechanics" now ready. Machinists say "Can't get along without it." Best in the land. Shop kinks, secrets from note books, rules, formulas, most complete reference tables, tough problems figured by simple arithmetic. Valuable information condensed in pocket size. Price postpaid $1.00 cloth; $1.25 leather with flap. Agents make big profits. Send for list of books. E. H. SAUNDERS, 216 Purchase St., Boston, Mass.

WANTED.—Agents in every shop to sell Calipers. Liberal pay. Address E. G. SMITH CO., Columbia, Pa.

WANTED.—Salesmen visiting hardware, sheet metal workers' and boiler makers' trade to carry as a side line our highly recommended modern portable hand metal punch. Endorsed and used by five largest U. S. navy yards and arsenals. Sells itself on merit. Send references. Only business getters answer. W. A. WHITNEY MFG. CO., Rockford, Ill.

WANTED.—Partner on patent of a tool for mechanics' use. Will give one-third interest for expense of patent, or will sell idea outright. Apply E. H. THORNE, Hagan, Ga.

WANTED.—A first-class man to take a position as factory superintendent with a concern which has been in the argicultural implement business for fifty years. Lawn mower experience preferred. Must be able to reduce costs, handle men, and a man with drafting experience preferred. A good position for the right party. Address "G," care MACHINERY, 49 Lafayette St., New York.

WANTED.—Copy of MACHINERY, Engineering Edition, for September, 1907. Address with price, FOREIGN DEPT., MACHINERY, 49 Lafayette St., New York.

WANTED.—A skilled and experienced machine designer about 28 to 32 years of age for a teaching position in a technical school in the East. Pleasing and forceful personality and enthusiasm required. Entering salary about $1,500.00. Apply, stating age, education, practical experience and any other qualifications in detail to "X," care MACHINERY, 49 Lafayette St., New York.

WANTED.—General Manager of your firm to learn that I can reduce the cost of production of any article of manufacture by special machinery. Send me a sample or drawing of the piece to be made and its present cost to produce, and I will answer, stating for what price I can produce it and the first cost. Will call if work justifies. JOSEPH J. HOSLER, 30-31 Eagle Block, Canton, Ohio.

YOUNG MAN, 22 years of age, of good character and best of references, desires position with an electrical firm. Has had experience, and possesses technical knowledge. Address W. W., Box 423, Newark, N. J.